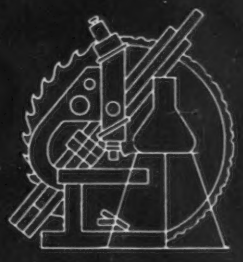
QUALITY CONTROL IN VENEER INDUSTRY—p. 85

Forest Products Journal



Vol. VII, No. 2 February, 1957

Special Issue

ANNUAL REVIEW

1956 Developments in Major Segments of the Forest Products Industry

VENEER AND PLYWOOD

FINISHING

GLUING

PRESERVATION

LOGGING

CHEMICAL UTILIZATION

MILLING

WOOD DRYING

World-Wide Forest Products Review

by Food and Agriculture Organization of United Nations

Published by the FOREST PRODUCTS RESEARCH SOCIETY BOX 2010 MADISON 5, WISCONSIN

CYANAMID

ANNOUNCES:

Two new low-pressure board surfacing resins

CYZAC* resin 2247
CYZAC resin 2352

New prospects for laminated wood finishing! How would you like to be able to produce, directly on low-density particle board or on hardboard-faced plywood, finishes and surface characteristics approaching those of high-pressure decorative laminates?

This is the prospect opened by Cyanamid's new CYZAC Resins. Print grade or overlay grade laminating papers may now be laminated directly to a particle board or wood surface.

CYZAC Resin 2247 is formulated for impregnating print-grade laminating papers to produce decorative surfaced hardboards for use as wall panels, door panels, cabinets, do-it-yourself applications, low-cost furniture and TV cabinets.

CYZAC Resin 2352 provides the most satisfactory characteristics in impregnated overlay-grade laminating papers. Laminated directly to wood surfaces at moderate cost, it produces a transparent, colorless finish with excellent surface properties; it may even be applied over stained surfaces. The finish gives outstanding beauty and durability to flat working surfaces of tables, dressers, desks and chests. CYZAC Resin 2352 offers new ease of handling and application for producing prefinished lumber products at lumber mills.

For further details on application techniques and properties, send for our technical data sheet. Your Cyanamid Technical Service representative will welcome an opportunity to help.

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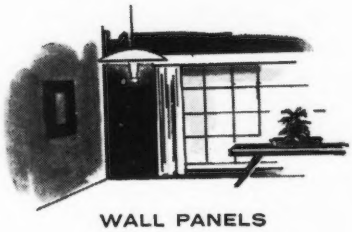
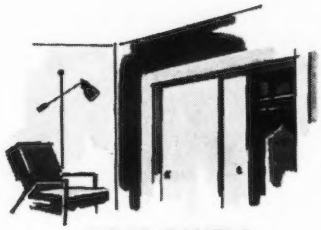
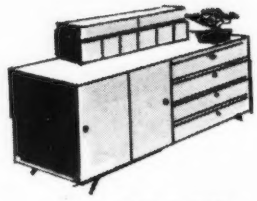
SOME OF THE 999 APPLICATIONS



WALL PANELS



DOOR PANELS



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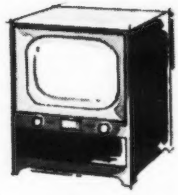

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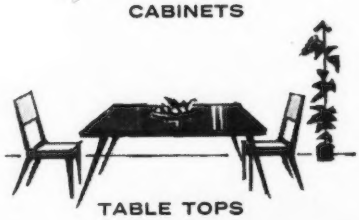

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IMPORTANT FPRS DATES

April: Midwest Section Meeting, St. Louis, Mo.

April 11–12: Ohio Valley Section Meeting, Louisville, Ky.

May 2–3: Northern California Section Meeting, Berkeley, Calif.

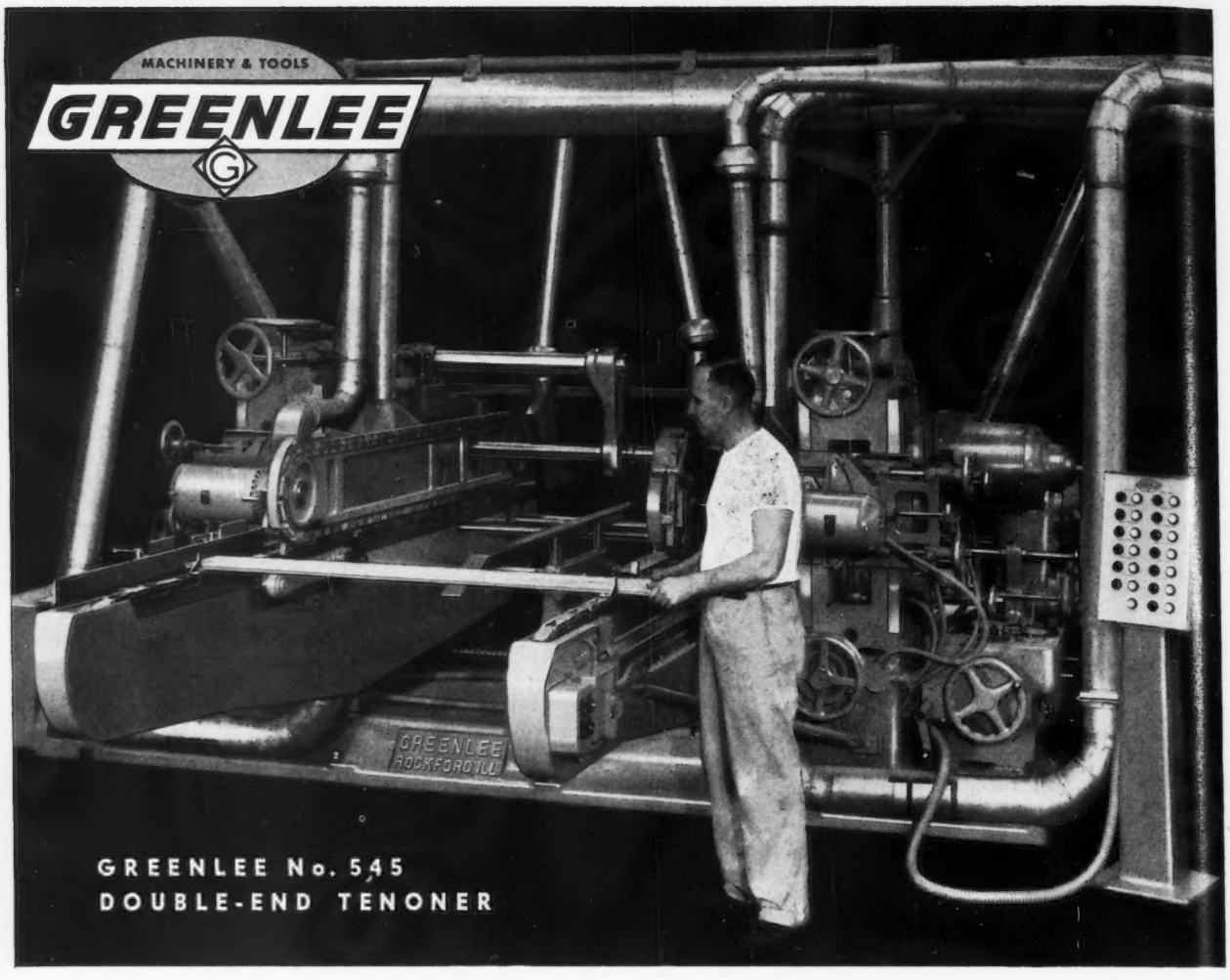
May 9–10: Carolinas–Chesapeake Section Meeting, Clemson, S. C.

May 13–14: Pacific Northwest Section Meeting, Roseburg, Ore.

May: Upper Mississippi Valley Section Meeting

May: Florida–Georgia–Alabama Section Meeting, Talladega, Ala.

June 24–28: Eleventh National Meeting, Hotel Statler, Buffalo, N. Y.



Has Returned 100% On The Investment In Less Than One Year

MACHINERY FOR
PLANING
SHAPING
TENONING
MORTISING
BORING
AND SAWING

This is a matter of record for all to see (plant names and case histories on request).

Phenomenal, yes . . . but not surprising, because this versatile machine can perform many cost-cutting operations in one pass . . . dadoing, scoring, dovetailing, notching, relishing, sill-horning, irregular shaping, etc.

It works to close tolerances, too . . . a few thousandths if required . . . eliminates costly "hand fitting". Well-known for its low-cost, long-lived, trouble-free operation.

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ROCKFORD, ILL.

Kill next summer's weeds now!

SOIL STERILANTS APPLIED IN WINTER AND SPRING KEEP GROUND BARE ALL YEAR

Now is the time of year to rid yards, roadbeds, and ditches of next summer's fire-hazardous weeds and grasses. Just apply an economical soil sterilant to eliminate all vegetation for a year or more. No need for costly periodic chopping or cutting, because the weeds are killed at their roots by the poison-laden rainwater. Mail coupon for more information on these effective weed, brush, and grass killers distributed by Chapman Chemical Company.

WEED KILLERS RECOMMENDED FOR WINTER AND SPRING APPLICATION

CONCENTRATED BORASCU*—Destructive to all types of vegetation. Can be applied dry, cast by hand or with a fertilizer or seed spreader. Concentrated form saves transportation, handling and storage costs.

BARON*—Dow Chemical Company's new nonselective herbicide that remains in the soil for extended periods of time, giving control of germinating seedlings following initial treatment. Mixes easily with water.

TELVAR* W—Industrial-use weed and grass killer produced by Du Pont. Wettable powder applied by sprayer, economical for large and small areas.

TELVAR DW—Similar to Telvar W but remains in soil longer under adverse conditions. Recommended for use in light, sandy soils and where rainfall is exceptionally heavy.

**BORASCU—Reg. trademark of United States Borax & Chemical Co., Pacific Coast Borax Co. Division. BARON —Reg. trademark of The Dow Chemical Co. TELVAR— Reg. trademark of E. I. du Pont de Nemours & Co.*

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☐ Telvar W ☐ Telvar DW

*Name*_____

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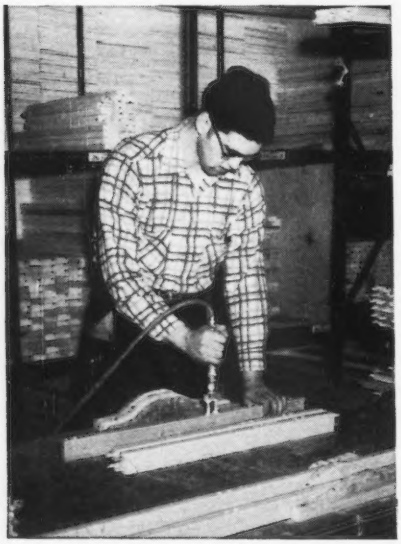
AUTOMATIC DOWELLING
WOOD-LOK is applied with automatic glue gun for dowels on hard rock maple assembly. Joints are stronger than with any other type adhesive.



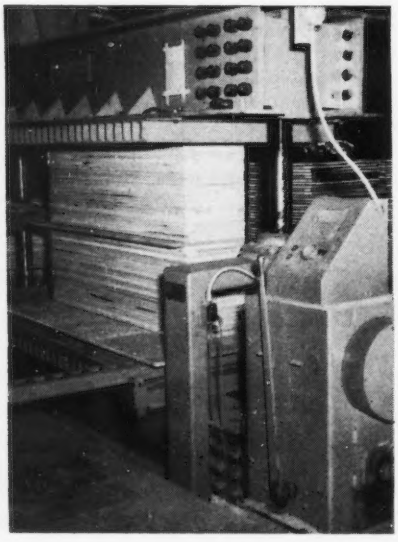
NO CHILLED JOINTS
WOOD-LOK allows 5-7 minutes open assembly time. This interval is more than enough for precision alignment in edge gluing extra long stock.

STRONGER GLUE BLOCKING
WOOD-LOK bonded blocks hold face frame to sides of cabinet. No nails or screws are used. Superior tensile strength of glue line insures durable construction.

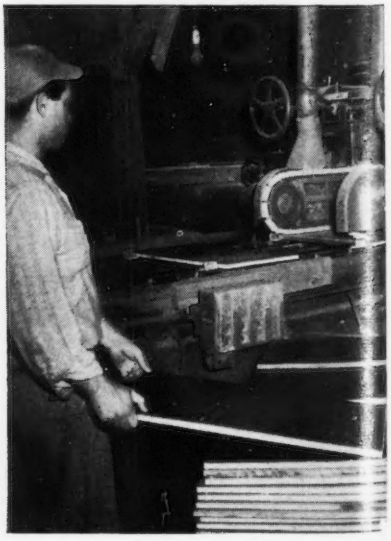
SPEEDS LAMINATING

SIMPLIFIED GLUING
WOOD-LOK requires no mixing. It's virtually odorless. Nonirritating to skin. Lasts all day in the pot. Moreover, it cleans up readily with water.

NO I-BEAMS OR CLAMPS
WOOD-LOK needs only a 15-30 minute press. No I-Beams, clamps or curing rooms are necessary. Assembly time: up to 45 minutes without danger of precure.



FASTER MACHINING
WOOD-LOK laminated doors can be trimmed one hour after pressing. Glue line is practically nonabrasive. Saves cost of frequent blade resharpening.



WOOD-LOK® Does two jobs at Oxford Cabinet Co.

FROM THE ROUGH LOG TO FINAL FINISH—Oxford Cabinet Company, Oxford, Pa., harvests its own timber lands. Saws into lumber. Assembles. Does everything—in combining the beauty of Birch and Sound Knotty Pine with utility and compactness for today's streamlined kitchens.

Oxford's assembly work and laminating are faster. Stronger. Why? Because of the setting speed, strength and convenience of WOOD-LOK, National's cold run, ready-for-use resin glue.

WOOD-LOK may well modernize your operations, too. One of National's sales technicians will be glad to show you how. Just write. Or telephone your nearest National office.

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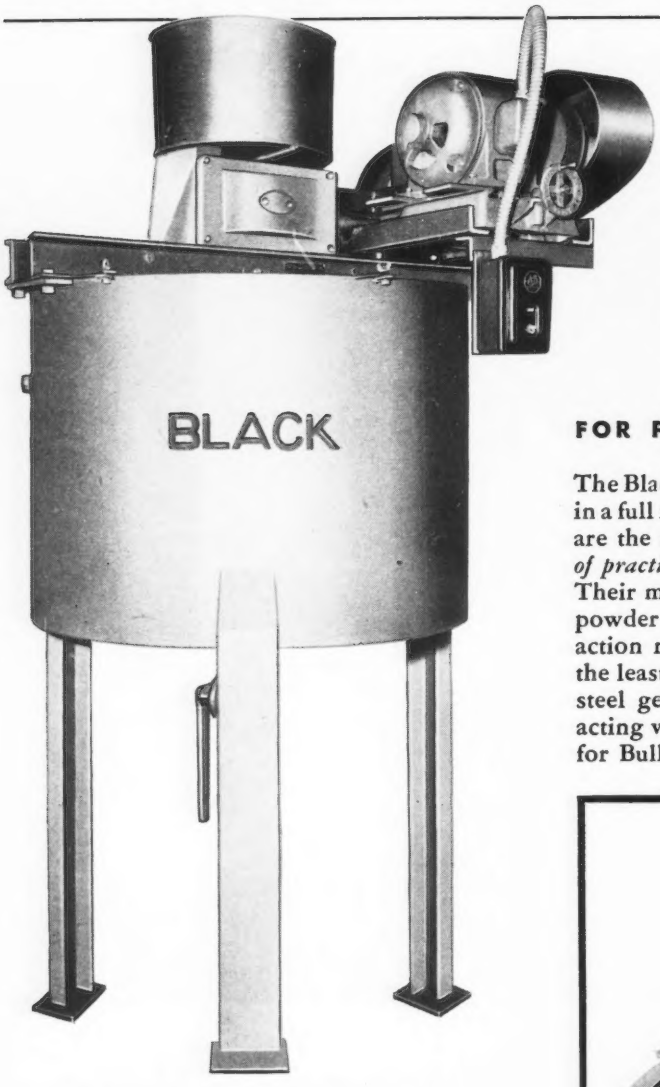
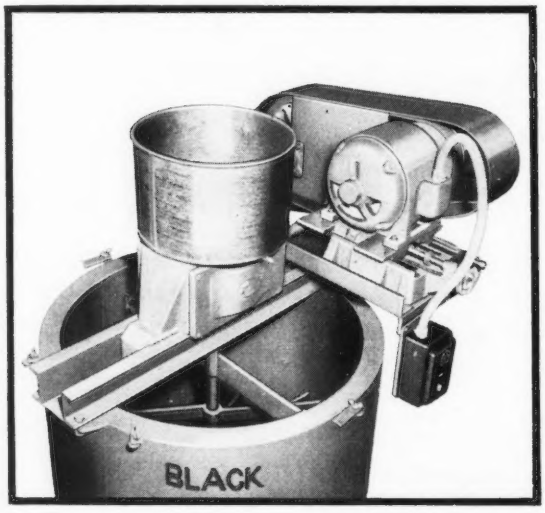
THE BLACK BROTHERS



Cold glue MIXERS

FOR POWDERED OR LIQUID ADHESIVES

The Black Brothers stationary cold glue mixers are made in a full range of capacities from 10 to 500 gallons. They are the result of *expert engineering combined with years of practical experience in glue equipment manufacturing.* Their many special features include: (1) Sifter for glue powder (2) Double agitators which give a beating action resulting in the smoothest possible mixture in the least possible time (3) Pressure lubrication (4) Cut steel gears . . . hardened and lapped (5) Large quick-acting valve at bottom. For full information write today for Bulletin 11-I.



TWO-WAY AGITATION ▶

To the right is a partial view of a 60 gallon cold glue mixer arranged with a variable speed drive and water jacket. The covers have been removed showing accessibility for cleaning, and also the double agitator arrangement. Note the thick double walled tank permitting free circulation of water for cooling the glue batch.

PORTABLE MOTOR DRIVEN GLUE MIXER ▶

The Black Brothers portable motor driven cold glue mixer is made in 2, 5, 7½, and 15 gallon sizes. It has a number of exclusive Black Brothers features such as a glue powder sifter, two-way agitation, and specially shaped flat paddles to give a beating action to the agitator. In addition this convenient, portable mixer has a hinged arm that may be swung up to allow the pail to be inserted or removed. This mixer is also being used extensively in the mixing of catalysts and hardeners. Write for Supplement to Bulletin 11-I.

"If It Is Gluing Equipment — We Have It"

THE BLACK BROTHERS CO., INC.

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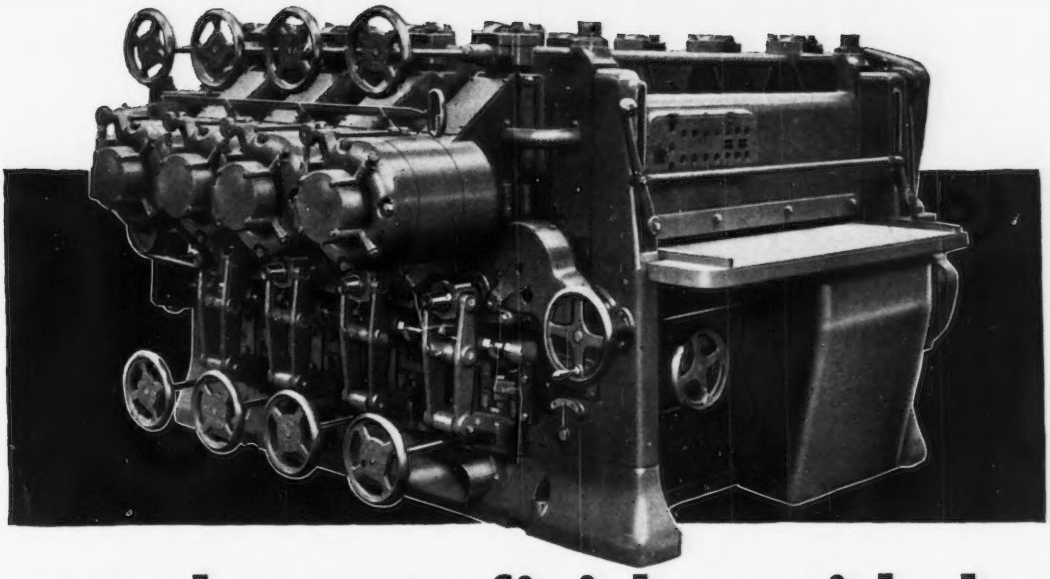

Improved way to finish particle board

eliminates chip-tearout problems

Mills using Yates-American Double-Deck Sanders come up with performance figures that are eye-openers!

You must agree that we at Yates-American can be unbiased in discussing the merits of surfacers versus sanders in chip-core operations. After all, we make both types of machines.

We feel that Yates-American surfacers are the finest. But — it is our honest opinion that *any* surfacer has *limitations,* when it comes to finishing particle board.

We estimate that about 60% of the end-use requirements for particle board call for a smooth finish you can get only from a *sander* — the Yates-American Double-Deck, in particular. Leading mills throughout the country back us up on that!

Does the Entire Job!

With the Yates Sander, finishing particle board is done in *one* operation:

It removes up to 3/16″ of stock (depending upon density of board) —at rates up to 50 feet per minute. It holds tolerances of less than ±.002″ over an entire sheet — *that we guarantee!*

There are no expensive carbide knives to joint, regrind, and reset. *No knife marks or chip tearout.*

Preferred by Leaders!

Leading companies like these have already purchased Yates-American Double-Deck Sanders:

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Everett, Washington

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Wabash Screen Door Co.
Minneapolis, Minnesota

Weyerhaeuser Timber Co.
North Bend, Oregon

Wynnewood Products Co.
Jacksonville, Texas

Don't you think a Yates Double-Deck Sander should figure in *your* particle board plans? Ask your nearby Yates-American man to make recommendations. Or write, wire, or phone us today at Beloit.

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First with the *Finest* in woodworking machinery. Established in 1883

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WW-9

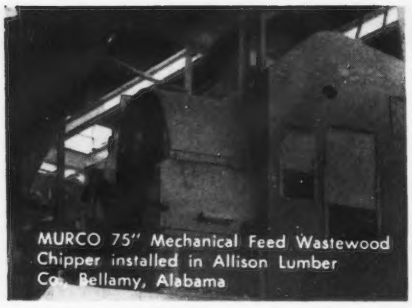
How's this for SANDPAPER LIFE!

Here are some figures that are hard to believe — we blinked once or twice ourselves, when we first saw them. But they're fact — actual performance figures supplied to us by two reputable companies, names you'd recognize at once.

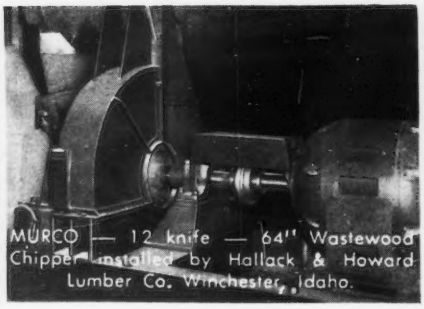
Both mills are finishing particle board with a Yates-American Double-Deck Sander and are removing up to 3/16″ of stock. This is what they report on sandpaper life:

First two pairs of drums.....1200 to 1500 hours
Third pair of drums..... 500 to 700 hours
Fourth pair of drums..... 150 to 200 hours

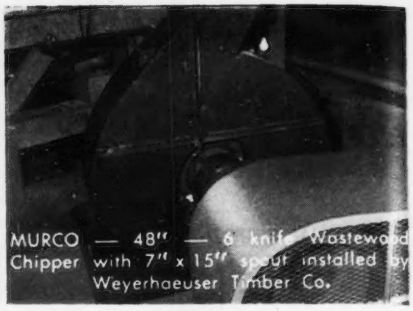
We repeat — these are not *our* figures. They've been furnished to us by *two different mills* and have been confirmed and re-confirmed.



MURCO 75" Mechanical Feed Wastewood Chipper installed in Allison Lumber Co., Bellamy, Alabama



MURCO — 12 knife — 64" Wastewood Chipper installed by Hallack & Howard Lumber Co. Winchester, Idaho.



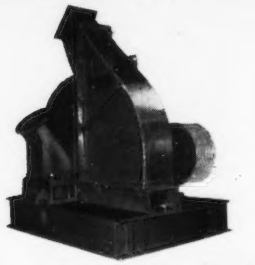
MURCO — 48" — 6 knife Wastewood Chipper with 7" x 15" spout installed by Weyerhaeuser Timber Co.

MURCO
WASTEWOOD CHIPPERS

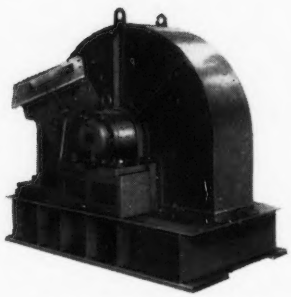
Produce... marketable chips from sawmill waste!

Produce quality specification-size chips from slabs, edgings, planer trimmings, round wood, veneer cores, etc., with MURCO Wastewood Chippers. The most versatile, flexible chipper design now available to chip producers is being used by lumber companies to produce quantity production of quality specification-size pulpwood chips. MURCO Wastewood Chippers operate with a minimum of slivers, sawdust and chip rejects . . . economically priced . . . low maintenance cost and in addition to use in the mill, can be used as a portable unit, mounted on skids or trailer for Diesel engine drive. Illustrated are the MURCO High Speed Multi-Knife Chipper . . . made in three sizes, 56", 64" and 72" diameter discs, and the economy small log chipper with V-Spout and blower housing—made in sizes 36", 42", 48", 54", and 60" disc diameters. All MURCO Wastewood Chippers are built along the general lines of MURCO Pulpwood Chippers with over thirty years' experience in the manufacture of chippers . . . ruggedly built for production.

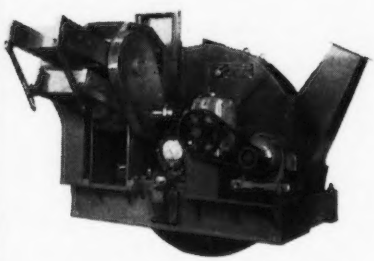
MURCO 75" diameter 4-knife mechanical feed wastewood chippers have the spout feed mechanism synchronized to the speed of the disc to produce uniform size chips . . . capacity when operated at 500 RPM and set to cut ⅝" to ¾" chips is approximately 10 cords per hour.



MURCO SMALL LOG CHIPPERS



MURCO MULTI-KNIFE WASTEWOOD CHIPPERS



MURCO MECHANICAL FEED WASTEWOOD CHIPPERS

other MURCO products include . . .

V-Type Spouts for pulpwood chippers . . . Multiple Knife Chipper discs . . . Pulpwood Slashers . . . Hydraulic Wood Splitters . . . Knot Screens . . . Chip Crushers . . . Re-Chippers, Barking Drums . . . of interest to lumber companies who produce pulpwood chips.

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You get the glue you need, in any desired quantity, when you need it.
You get competent technical advice from National Casein's men who know glues.
You get the right glue for your job, priced right.

3 reasons why you buy National Casein glue

All glues aren't alike—a fact we've proved to the satisfaction of men who buy glues for practically every type of glue job.

We've also discovered three major reasons why these men who know glues prefer to buy National Casein glues.

First, we are equipped, staffed and experienced in giving our customers reliable service. Same day shipment on most orders received.

Second, your contacts with our factories are through competent, experienced, and practical glue men—men who also know glues.

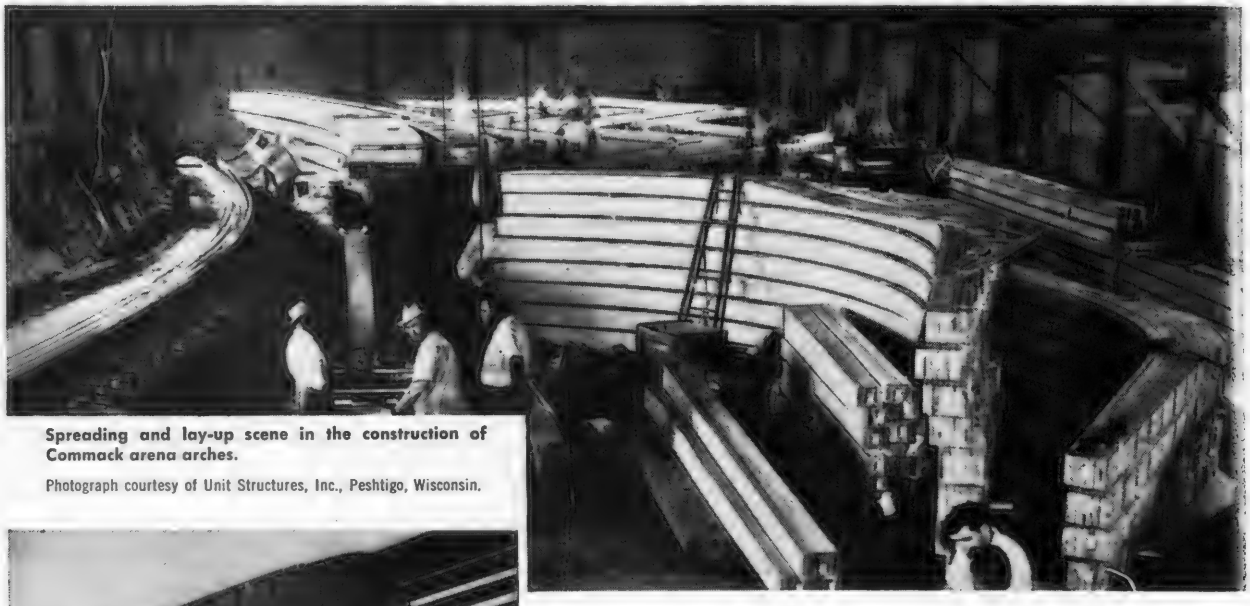
Third, you get from NATIONAL CASEIN the right glue for your glue job—Urea, Casein, Polyvinyl, Resorcinol, Phenolic or specialty glues to meet your own particular requirements—priced right for the top quality delivered.

You be the judge! Write us at the office nearest you how much of any of National Casein's complete line of glues you need for a convincing test. Tell us if you want one of National Casein's Glue Men to contact you. No cost! No obligation!

National Casein

National Casein Company, 601 West 80th Street, Chicago 20, Illinois
National Casein of New Jersey, Broad and Fulton Streets, Riverton, New Jersey

Laminated Construction Timbers BONDED BETTER with PENACOLITE® Resorcinol Adhesives



Spreading and lay-up scene in the construction of Commack arena arches.

Photograph courtesy of Unit Structures, Inc., Peshtigo, Wisconsin.

PENACOLITE-laminated arches like these are erected rapidly and economically. Moreover, the natural beauty of wood is preserved in the basic construction. Twelve of these giant arches were erected for the Commack, Long Island arena last summer.

Laminated structural timbers are receiving increasingly wide use in many kinds of building construction—schools, gymnasiums, public arenas and others. The laminated construction of these basic building supports makes them readily adaptable to requirements of size and shape. Furthermore, with their use, the difficult problem of finding single piece timbers large enough to meet specifications is completely eliminated.

Because of PENACOLITE adhesives' waterproof qualities and great bonding strength, they are specified for many important construction jobs. Bonds made with these specially formulated adhesives resist the shrinking and swelling of wood, and are unaffected by atmospheric humidity and temperature extremes. PENACOLITE adhesives set, even at room temperature, into bonds as strong as the woods they join. They are quickly applied and will not weaken with age or long exposure.

Investigate PENACOLITE Resorcinol Adhesives by sending for our free, illustrated booklet describing their many advantages and great variety of applications. Koppers Company, Inc., Dept. FPJ-27, Chemical Division, Pittsburgh 19, Pennsylvania.

KOPPERS

PENACOLITE® RESORCINOL ADHESIVES

The original waterproof room-temperature-setting adhesives

Sales Offices: PITTSBURGH · NEW YORK · BOSTON · PHILADELPHIA · ATLANTA · CHICAGO · DETROIT · HOUSTON · LOS ANGELES · SAN FRANCISC

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Buy BUSS and get the PLANER that EXACTLY suits YOUR needs!

NO OTHER LINE OFFERS SO MANY MODELS AND SIZES

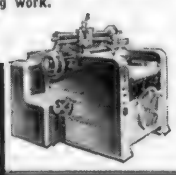
When you buy a BUSS planer you not only get a machine that will give you the best job of planing in the shortest possible time, but a machine that is virtually custom built to *your* particular production requirements. For example: Our Model 44, 4-roll and Model 66, 6-roll single surface cabinet planers are available in a total of *13 sizes as compared to two to four sizes of machines in the same category offered by other planer manufacturers. In addition, we have all the other models shown below, available in various capacities. Consequently, when you buy a BUSS planer you never need pay for extra capacity you do not need. But, on the other hand, when extra large capacity is a real asset, you'll find that BUSS offers a planer of larger capacity (52″ width) than any other on the market. Obviously, we are exceptionally well situated to provide you with the planer that will net you the greatest return that can be had from an investment in planers. Let us consult with you on your requirements. Bulletins on request.

***MODEL 44 CAPACITIES:**
26, 30, 36, 40, 42, 50, and 52 inches x 8 inches.

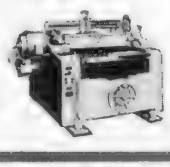
***MODEL 66 CAPACITIES:**
30, 36, 40, 42, 50, and 52 inches x 8 inches.

THERE'S A BUSS PLANER TO EXACTLY SUIT YOUR NEEDS

No. 4-L Single Surface, medium sized planer for first cutting and finishing work.

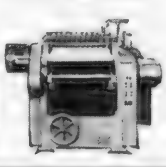


No. 66 Single Surface, 6 roll planer for first cutting and finishing work.

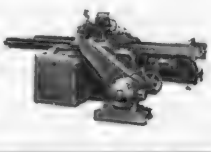


No. 88 Double Surface, 8 roll planer for first cutting and finishing work.

No. 55 Heavy duty Double Surfacer for planing rough lumber.



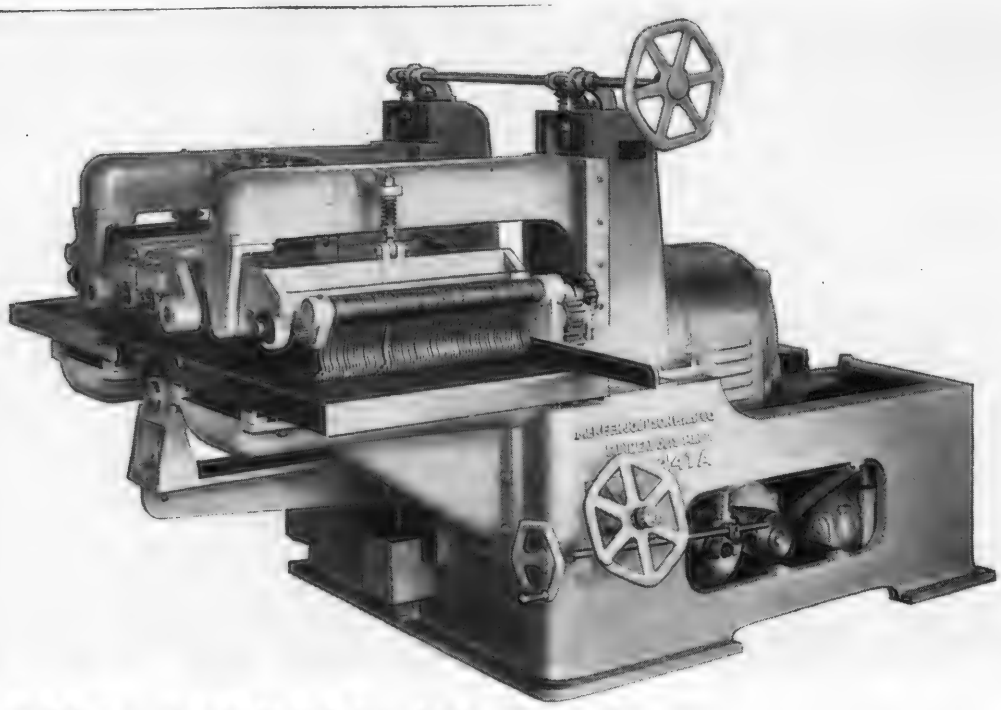
MICRO-SURFACER for planing hardboard and other very thin materials.



BUSS
SINCE 1862
MACHINE WORKS

PLANER SPECIALISTS EXCLUSIVELY

EIGHTH STREET • HOLLAND, MICHIGAN



MEREEN-JOHNSON NO. 441A

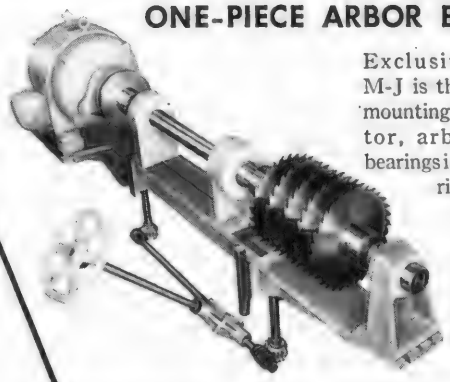
extra heavy duty GANG RIP SAW

MEREEN-JOHNSON has manufactured gang rip saws for 40 years. Power, speed and accuracy have always characterized M-J machines. This new No. 441A has all the features of previous models, with some important new ones added.

- Now *eight power-driven feed rolls*—two pair infeed and two outfeed. This is a double safeguard where utmost accuracy of production is required.
- 7200 RPM arbor speed puts extra power where it's needed.
- Vertical arbor adjustment simplifies bed plate removal.

If your production includes sheet materials, hardwood flooring, furniture core stock or wirebound boxes—it will pay you to investigate this big, rugged M-J No. 441A Rip Saw.

ONE-PIECE ARBOR BEAM



Exclusive with M-J is this beam mounting of motor, arbor and bearings in a single rigid unit.

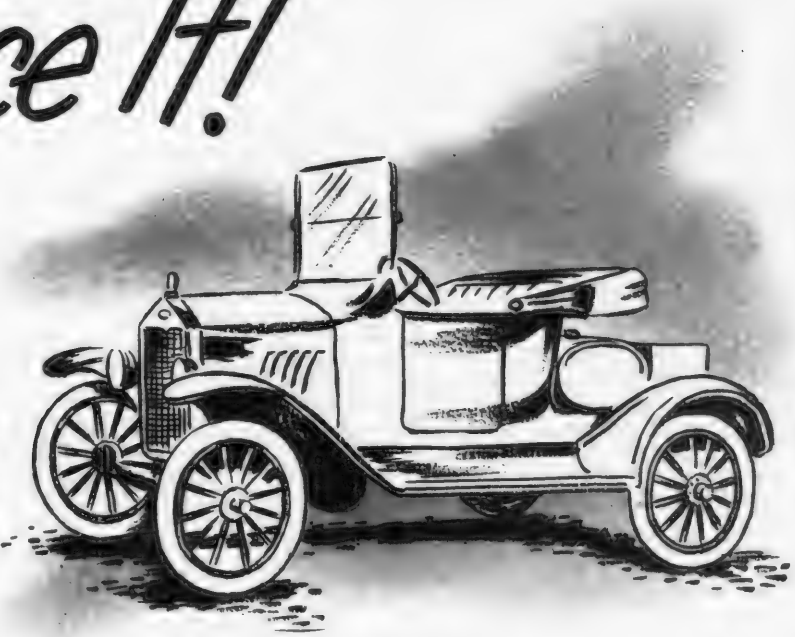
MEREEN-JOHNSON MACHINE CO.
4401 LYNDALE AVE. NO. - MINNEAPOLIS 12, MINNESOTA

CUT-OFF SAWS	DOUBLE CUT-OFF SAWS	MULTIPLE CUT-OFF SAWS	GANG RIP SAWS
TENONERS	VENEER & PLYWOOD SIZERS & JOINTERS		RESAWS

Send For The No. 441A Bulletin

Let's Face It!

IT STILL RUNS ...BUT



you wouldn't depend on it for transportation today. Similarly, old woodworking machines can hardly be depended upon to produce *profitably* in today's competitive markets.

DO YOU *KNOW* HOW OLD YOUR MACHINES ARE?
DO YOU *KNOW* WHAT MODERN MACHINES WILL DO FOR YOU?

In this period of changing skills when more and more people come to you with high school and college educations, the emphasis is on mental rather than physical job requirements. Modern machines attract this better help . . . upgrade your labor force. Modern machines produce profitably for you. Get your machine replacement program moving. Start now and shift it into high gear today.

Put a profit in your woodworking with MODERN MACHINES

WOODWORKING MACHINERY MANUFACTURERS ASSOCIATION

WOODWORKING MACHINERY MANUFACTURERS ASSOCIATION
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WOODWORKING MACHINERY MANUFACTURERS ASS'N.
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Please send further information. I am interested in the following types of machinery

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Company_____
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HIGH WATER RESISTANCE

*RESINOX, LAUXEIN, LAUXITE: REG. U.S. PAT. OF.

MONSANTO LAUXITE MF300, a melamine adhesive, fortifies urea mixes for high water resistance—at little or no extra cost! Just 10% of LAUXITE MF300 in a urea formulation produces a more stable glue mix with improved wetting action. Assembly time is less critical. There's less chance of pre-cure in hot, humid weather. The fortified mix has high resistance to delaminatio in boiling. And the reduction in glue spread poundag can offset additional material costs.

Write today for test samples and technical literatur to Monsanto Chemical Company, Plastics Divisio Room 1641, Springfield 2, Mass.

Other outstanding Monsanto Adhesive Resins are:

LAUXITE 326 *A melamine-urea adhesive for hot press gluing when greater boil resistance is desired.*

LAUXITE MF-325 *A specially formulated powdered melamine resin binder for granulated wood.*

RESINOX *Phenolic resins, liquids and compounds, for granulated wood molding and hardboard.*

LAUXEIN *Versatile protein adhesives with specific formulations to meet varied bond requirements.*

LAUXITE UREA *Resin glues, both liquid and powder, for high water resistant bonds.*

MONSANTO®

Monsanto supplies a complete line of Urea, Melamine, Resorcinol, Phenolic and Protein adhesives for the woodworking industry.

100th anniversary

1856

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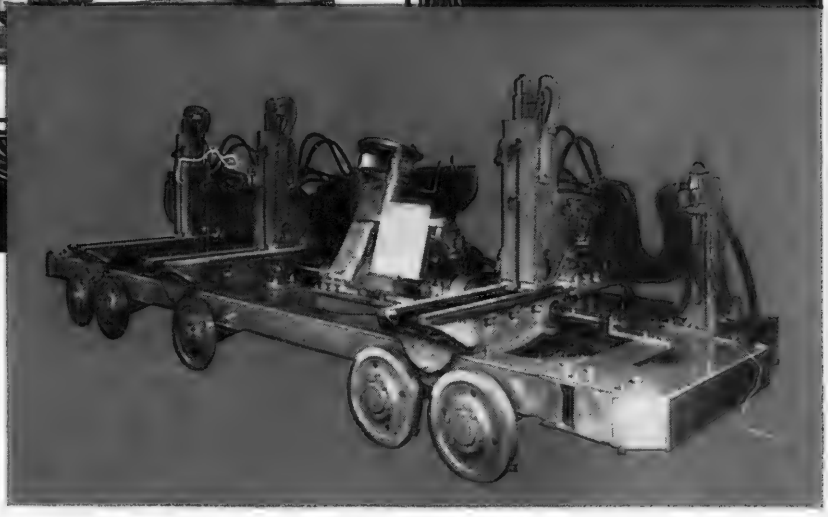

WORLD'S LARGEST BUILDERS OF HEAVY DUTY SAWMILL MACHINERY

This year marks the beginning of the second one hundred years that Filer & Stowell will serve the lumber industry in the development and manufacture of sawmill machinery.

Filer & Stowell is proud of its service to the lumber industry over these past one hundred years and of the name "Filer & Stowell", which is now on sawmill machinery used all over the world.

As we rededicate ourselves to another century of serving the lumber industry, we want to thank our customers, for it is they to whom much cerdit must go for the growth of Filer & Stowell.

The Filer & Stowell Company

MILWAUKEE 7, WISCONSIN

Takes most patterns

fits all machines!

Series 640 head with eased-edge bits.

Takes most patterns, fits all machines!

Yates-American Series 640 "K" Clamp Head

Naturally you want the most for your money, when you buy a head. And that's what Yates-American Type "K" Heads give you!

Take the versatile Series 640 shown above. It's an eight-bit, all-purpose side head with self-centering sleeve. You can use it safely at high speeds on either right or left spindles. You have less breakage — fewer hours of machine downtime.

This head has adjustable bit-clamps that fit 30° dovetails. You can adjust bits laterally. Corrugated bit-seats grip the bits securely — so every cut is smooth and chatter-free.

You can interchange innumerable patterns. And — because you can, you save the expense of the extra heads you'd need otherwise.

Catalog K-101 tells you more about "K" Clamp Heads and describes the complete line of Yates-American Heads and Knives. Write for free copy.

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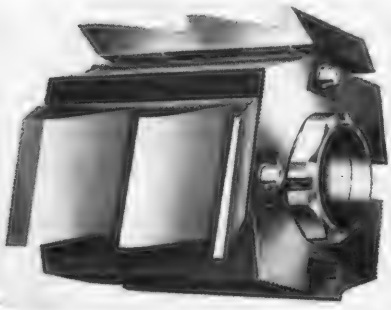
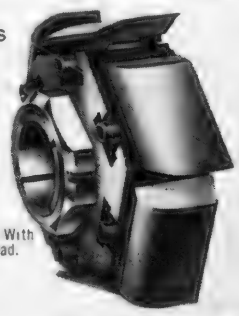
BRANCH OFFICES: CHICAGO, ILL. • HIGH POINT, N. C. • MEMPHIS, TENN. • PORTLAND, ORE.
First with the *Finest* in woodworking machinery. Established in 1883

MATCHERS • MOULDERS • SURFACERS • RIPSAWS • RESAWS • SANDERS

OTHER VERSATILE "K" CLAMP HEADS



Series 620 — For profile work on top and bottom moulder spindles or profile spindles of matchers. Takes both narrow and wide bits. Equipped with self-centering sleeve.



Series 630—For top and bottom spindles. With special sleeve, can be used as side head.

WW-1

FPRS NEWS-DIGEST

Volume VII FEBRUARY, 1957 Number 2

New Cost Guide Developed for Woodworking Industries

A cost guide to gauge chances for success of new wood processing ventures has been published by the Oregon Forest Products Laboratory, Corvallis. Written by Larry Coolidge, chairman of business administration, Oregon State College, and Jack Pfeiffer, in charge of wood seasoning at the laboratory, the booklet, "Cost Estimating for Wood Industries" adapts to wood industries some estimating principles long applied in other businesses.

To judge the value of a proposed development, the authors found that certain critical questions needed answers, such as the investment in physical plant and working capital required to start production, production cost, selling and distribution costs, whether selling price will yield adequate return, and the most profitable scale of operations. Application of principles adapted from other industries makes it possible to answer these questions within 20 per cent accuracy.

In-place process equipment represents half the entire cost of the physical plant. Other costs in building the physical plant are calculated as percentages of the installed cost of process equipment: site preparation, 5.5; buildings and building services, 20.0; process piping, 6.5; electrical installation, 9.0; utilities, other service facilities, 9.0; construction overhead, 30.0; and allowance for contingencies, 20.0 per cent. Operating costs include raw materials, labor, investment, selling, management, and costs dependent on these items.

For a given process and production rate, raw materials, utilities, and labor can be calculated. Costs dependent on labor and investment are found by use of estimating factors. Selling costs are highly variable but, together with management costs, may be estimated as 15 per cent of production costs.

To estimate profit or loss, annual sales volume and price must be predicted, desired pay-out period stated, and acceptable rate of return on investment fixed, the analysts state. With such predictions and decisions made, estimated profits can be calculated from operating costs, plant investment, annual production, and average selling price.

Pallet Industry Sets New Production Record

A new production record for the wooden pallet industry was set in 1956 with a sales volume in excess of $125 million, it was reported at the 10th semi-annual meeting of the National Wooden Pallet Manufacturers Association in Hollywood, Fla. Members and guests present were told that the outlook for 1957 is good, but that the rate of possible increase will be much slower than in the past three years.

Highlights of the 1957 trade promotion program of N.W.P.M.A. include: publication of a pamphlet of factual information on care and maintenance of wooden pallets; publication of a technical brochure on wooden pallet bins, pallet crates and pallet boxes for distribution to users and prospects; establish standard test procedures for evaluating wooden pallet construction and design; and begin a study of possible utilization of short length deckboards through new pallet designs.

Walter G. Moeling, III, Goodwater, Ala., was elected president of the association for 1957.

Timber Handbook Seen as Boost to Wood Construction

A definite impetus to increasing the use of wood as an engineering material, in light and heavy construction, is provided by the new 622-page technical book, "Timber Design and Construction Handbook," according to Harry G. Uhl, president of Timber Engineering Co., Washington, D. C.

R. H. Gloss

The Handbook, a complete master compilation of technical data on designing and building with timber, contains all essential basic information needed to develop the best and most economical structures in wood. It is a combination design reference, field manual, and textbook, produced for the convenience of architects, engineers, and other designers, and for instructors and students of these professions.

The material was coordinated by Teco under the supervision of Ralph H. Gloss, senior engineer, who served as co-author and editor. The entire work was prepared by 26 leading specialists of the lumber, wood products, and allied industries. Publishers of the book are F. W. Dodge Corp., New York.

Organized into three main sections, the handbook covers fundamental structures and characteristics of wood; general design procedure, details, fabrication, and erection; and design and engineering specifications and tabular data in simplified form allowing easy conversion for particular grades and species.

Palletized Boxes Discussed at Association Meeting

Keen interest in palletized boxes and crates for bulk handling of both industrial and agricultural products was reported at the 58th annual meeting of the National Wooden Box Association last month in Boca Raton, Fla. Development of specifications for re-usable containers and their promotion is on the association's market development program for the coming year.

Ken W. Kruger, U. S. Forest Products Laboratory, reported on the laboratory's facilities and activities in relation to the wooden box industry. Observations on overseas packaging performance were given by Leslie C. Heller, head of Packaging Section, Office of Navy Material, Washington, D. C.

Thomas Munroe, president and treasurer of Moraine Box Co., Dayton, Ohio, was elected president for the coming year. F. B. Joy, president of Ace Box Co., Denver, Colo., was elected a vice-president. Announcement was made that the mid-summer meeting will be held June 24–26 at Lake Placid, N. Y.

Nominations Being Accepted for 1957 Teco Scholarships

The National Lumber Manufacturers Association will award special scholarships again this year to outstanding college students majoring in wood technology or wood utilization. Each scholarship will carry a $500 cash payment, travel expenses, and ten weeks' on-the-job training in wood products research at the Timber Engineering Co. laboratory, Washington, D. C. At least four scholarships will be awarded and possibly more, depending on the number and qualifications of candidates.

Scholarship winners will be chosen on the basis of their scholastic ratings, general aptitude, and the recommendations of their schools. One senior or graduate student from each college or university offering a course in wood technology or wood utilization is eligible for nomination by his dean or department head.

The deadline for nominations is March 15 and winners will be announced April 15. On-the-job training at TECO will begin June 24. NLMA offers employment assistance to students who complete this course.

API Announces Graduate Fellowship in Forestry

Applications are now being received for the 1957 H. E. Westervelt Forestry Fellowship for graduate study in forestry at Alabama Polytechnic Institute, Auburn. The Gulf States Paper Corp., Tuscaloosa, Ala., offers the 1-year, $2,000 fellowship annually in honor of the firm's founder. Application forms may be obtained from W. B. DeVall, forestry department head, API School of Agriculture, Auburn, Ala.

Machinery Show Planned at Southern Pine Meeting

A logging and mill machinery exposition will be held in conjunction with the 42nd convention of the Southern Pine Association April 7–9 in the Roosevelt Hotel, New Orleans, La. The machinery demonstrations will begin on April 5, before the opening of the convention, in order to give mill-operating personnel an opportunity to attend over the weekend.

The show will be held at Pontchartrain Beach, with transportation being provided between the hotel and the lakefront. S. P. Deas, secretary–manager of the Association, reports that this will be the largest machinery show that the Association has sponsored.

Manufacturing and merchandising will be featured on the convention agenda. Norman P. Mason, national commisioner of the Federal Housing Administration, Washington, D. C. and Leon Clancy, president of the Southern Pine Association, will make keynote addresses.

Hill Will Address Southern Hardwood Producers Meeting

The outlook for the furniture industry and its relation to hardwood lumber is the subject of a keynote address to be given by G. Maurice Hill, vice-president and director of manufacturing, Drexel Furniture Co., at the annual convention of the Southern Hardwood Producers, Inc. The meeting will be held March 21–22 at the Roosevelt Hotel, New Orleans, La.

Other speakers at the meeting will include Thomas Gill, chief, seasoning and preservation section, Timber Engineering Co., who will discuss stain in red oak, and P. K. Seidman, certified public accountant of Memphis, Tenn., who will give an address on taxes. A panel will discuss the outlook for flooring and flooring oak lumber and NLMA's audio-visual program will be presented by Douglas S. Steinberg, director of public relations, Washington, D. C.

Kiln Drying Association Plans Organization Meeting

The formal organization meeting of the Egyptian Kiln Drying Association will be held March 22 at Hotel Cairo, Cairo, Ill. Membership in the association is open to all dry kiln operators, superintendents, managers, and other officials. Each member will receive as part of his membership the monthly wood drying news letter, published by the FPRS Wood Drying Division.

The opening session will consist of a demonstration of some fundamental kiln drying principles, given by William Rice, U. of Southern Illinois, and John Devine, Moore Dry Kiln Co. A panel discussion on various phases of kiln drying will follow.

U. S. Gypsum Leases Oregon Board Plant

Leasing of the insulation board and hardboard products plant owned by Oregon Fibre Products, Inc., Pilot Rock, Ore., has been announced by U. S. Gypsum Co.

Since completion in 1954, the plant's production has been marketed by U. S. Gypsum under a sales agency agreement. The new lease arrangement offers an increased sales opportunity to the company, particularly west of the Rockies, according to C. H. Shaver, board chairman.

O. W. Frost, general manager for Oregon Fibre Products, is Works Manager of the Pilot Rock plant under the new arrangement.

Forest Products Lab Announces 81st Kiln Drying Demonstration

Practical application of research findings will be the keynote of the 81st kiln drying demonstration to be held April 1–12 at the U. S. Forest Products Laboratory, Madison, Wis. The course will be given by the Laboratory's staff of seasoning research specialists, nine men who combine more than 200 years of experience in wood seasoning.

Subjects to be covered during the course include basic principles of air and kiln drying, types of dry kiln kiln equipment, kiln operation and tuneup, and moisture control during storage and production. Special emphasis will be placed on improved kiln-drying methods that can significantly reduce kiln time and seasoning degrade.

Open to architects, lumber wholesalers and retailers, contractors, and woodworking specialists, as well as kiln operators and supervisors, the course will include practical experience in drying charges of lumber under the supervision of the Laboratory staff. Those enrolled in the course will also work problems in the use of balances, scales, ovens, moisture meters, thermometers, recording-controlling instruments, and other dry-kiln equipment.

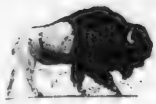
The fee for the demonstration is $200 per person, which includes materials and publications furnished enrollees for use as texts.

Hardwood Grading Course Scheduled in Syracuse

The Ninth Annual Spring Hardwood Lumber Grading Short Course will be held April 22–26 at the State University of N. Y. College of Forestry, Syracuse. The five-day course will include study and discussion of the grading rules presented in the National Hardwood Lumber Association Rule Book. Actual lumber grading practice with mixed hardwoods will be provided.

Other phases of hardwood lumber grading that will be discussed include: growth and structure of wood as reflected in grade and identification, an understanding of natural defects in lumber, and how to select the most suitable grade of lumber for the particular product that is manufactured. The course will be conducted by Lillard Nicely, Director Emeritus of the National Hardwood Lumber Assoc Grading School, Memphis, Tenn.

The registration fee of $35 covers all course expenses except hotel room, meals, and travel. Registration materials and additional information may be obtained by writing to the College of Forestry, Syracuse 10.



National Meeting Program Taking Shape

Advance Announcement of Technical Papers Planned for FPRS Buffalo Meeting

Plans are nearing completion for the technical program of the Eleventh National Meeting to be held June 24–28 at the Hotel Statler, Buffalo, according to Dr. Frank H. Kaufert, FPRS President-Elect and Program Chairman. A total of 12 technical sessions are planned, as well as an opening general session.

The schedule of activities also shows 11 subject matter division meetings and 3 committee meetings, as well as a wide range of entertainment for registrants and their families. One of the principal attractions will be the Wood Industry and Suppliers Exhibit to be held in conjunction with the meeting.

The following shows part of the wide variety of latest research to be reported at the technical sessions. Complete program details will be announced in a forthcoming issue.

Wood Finishing

"New Aspects in Paint Blistering"—D. F. Laughnan, U. S. Forest Products Laboratory, Madison, Wis.

"Wood Fillers"—P. A. Blackman, Glidden Co., Reading, Pa.

"Color Control in Wood Finishing"—Willis E. Martin, Grand Rapids Varnish Corp., Grand Rapids, Mich.

"Blister and Stain Resistant Paints"

"Natural Exterior Wood Finishes"

Wood Composition Board

"An Analysis of the Panel Products Field"—E. M. Williston, Weyerhaeuser Timber Co., Longview, Wash.

"Developments in Wood Composition Board"—Panel Discussion

Logging

"Obtaining Greater Logging Safety"—E. H. Reeves, Ontario Lumbermen's Safety Assoc., Toronto, Ont.

"Developments Leading Toward a Better Power Chain Saw"—James Conroy, Chain Saw Age, Portland, Ore.

"Harvesting Hardwood Logging Residues"—Leland Hooker, Michigan College of Mining and Technology, Houghton, Mich.

"Yarding with Rubber-Tired Wheel Skidders"—D. W. Gray, K. V. P. Co., Ltd., Espanola, Ont.

"Integrated Hardwood Logging"—J. C. Noblet, Calumet & Hecla Co., Calumet, Mich.

Lumber Manufacturing

"Dimensional Quality Control in a Large Western Sawmill—Charles M. Kreider and Marvin W. Coats, Brooks-Scanlon, Inc., Bend, Ore.

"Dimensional Quality Control in a North Central Hardwood and Softwood Sawmill"—D. M. MacRae, Connor Lumber & Land Co., Laona, Wis.

"Effect of Various Types of Equipment on Sawing Accuracy in Eastern Canadian Hardwoods and Softwoods"—Brodie Gillies, Gillies Bros. & Co., Ltd., Braeside, Ont.

"A Theoretical Basis for Dimensional Quality Control in the Sawmill"—J. S. Bethel, N. C. State College, Raleigh, N. C.

"Power Requirements for Log Carriage Setworks"—Milton H. Mater, Mater Machine Works, Inc., Corvallis, Ore.

Veneer and Plywood

"Manufacturing Hardwood Plywood in the Northeast"—Harry Fidler, Owens-Illinois Plywood Co., North Troy, Vt.

"Trends in the Hardwood Plywood Industry"—C. M. Wildes, Chief, Wood Products Branch, Industry Division, Bureau of Census, Dept. of Commerce, Washington, D. C.

"New Methods of Testing Hardwood Plywood"—C. A. Hart, N. C. State College, Raleigh, N. C.

"Plywood Pressing Equipment"—E. D. Cottrell, Setter Bros. Inc., Cattaraugus, N. Y.

Glues and Gluing

"Dielectric Properties of Resin Glues for Wood"—T. J. S. Cole and D. G. Miller, Forest Products Laboratories of Canada, Ottawa, Ont.

"End Gluing of Lumber"—D. B. Richards, Alabama Polytechnic Institute, Auburn, Ala.

"New Developments in Wood Gluing Processes"—Panel Discussion

Wood Drying

"Kiln Drying of Southern Hardwood Cross-Ties"—J. B. Huffman, University of Florida, Gainesville, Fla.

"Factors Affecting the Cost of Hardwood Drying"—Edwin Conway, Lumber Drying Specialties, Grand Rapids, Mich.

"Stacking, Stickers, and Related Problems"—Panel Discussion

"Mechanical Properties of Red Oak Related to Drying"

"Air Drying of Southern Pine"

Lignin Utilization

"The Lignin Dimethyl Sulfide Process"—W. M. Hearon, Crown Zellerbach Corp., Camas, Wash.

"Chemical Utilization of Lignin"—I. A. Pearl, Institute of Paper Chemistry, Appleton, Wis.

"Evaluation of Efficiency and Effects on Utilization by Various Methods for Removing Sugars from Lignosulfonates of Spent Sulphite Liquor"—G. A.

ADVANCE REGISTRATION

ELEVENTH ANNUAL MEETING—FOREST PRODUCTS RESEARCH SOCIETY
BUFFALO, NEW YORK—JUNE 24–28, 1957

Return to: Buffalo Convention and Tourist Bureau, 155 Franklin St., Buffalo 2, N. Y.

Name _____
Last First Middle

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Company or Organization _____

REGISTRATION (including abstracts)

					Enter Amounts Below
☐	FPRS Member	$ 8.00	☐ FPRS Official Luncheon	$ 3.00	$_____
☐	Non-Member	$12.00	☐ FPRS Banquet and Party	single $ 8.00	$_____
☐	Ladies Program	$ 5.00		couple $14.50	$_____

☐ Paul Bunyan Niagara Falls Tour and Smorgasbord—No Charge

Total Enclosed $_____

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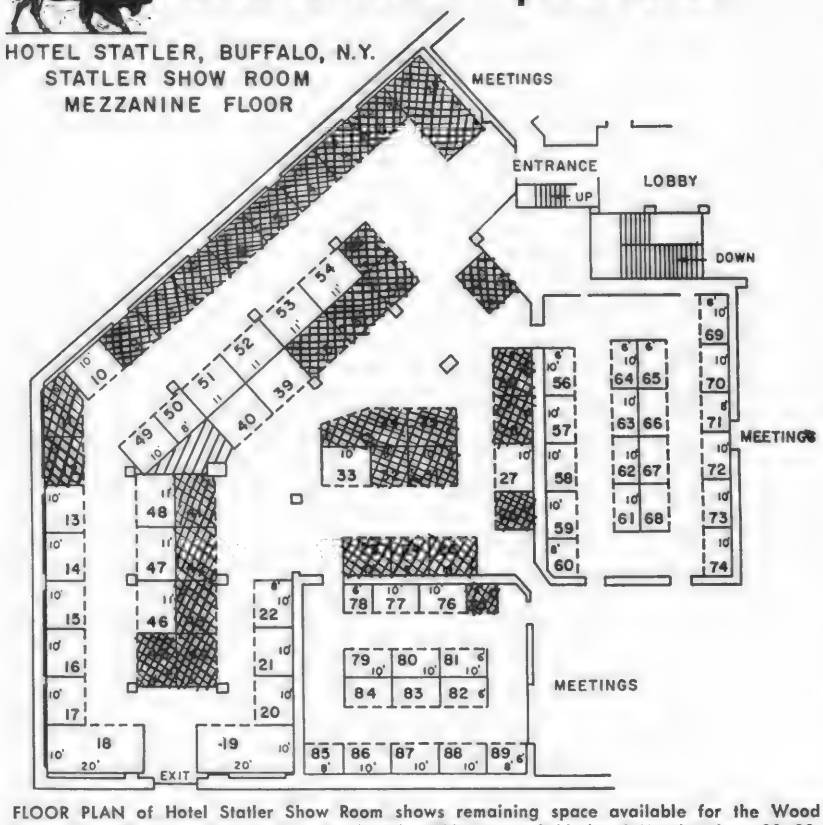

FLOOR PLAN of Hotel Statler Show Room shows remaining space available for the Wood Industry and Suppliers Exhibit to be held during FPRS Eleventh National Meeting June 23–28. Cross-hatched areas indicate space already reserved.

Dubey, L. A. Boggs, Philip Luner, and A. J. Wiley, Sulphite Pulp Manufacturers' Research League. Appleton, Wis.

"Activated Carbon from Spent Pulp Liquor"

Chemical Utilization

"Recent Advancements in Pine Gum Chemistry"—E. L. Patton and J. C. Braun, Naval Stores Station, Southern Utilization Research Branch, U. S. Dept. of Agriculture, Olustee, Fla.

"Chemical Properties, Derivatives and Uses of Levulinic Acid"—Carl Bordenca, Newport Industries, Inc., Pensacola, Fla.

"Separation and Properties of Hemicellulose, Cellulose and Hydrogenated Lignin from Sawdust"—Conrad M. Schuerch, State University of New York College of Forestry, Syracuse, N. Y.

"Extraneous Components of Western Red Cedar"—J. A. F. Gardner, Forest Products Laboratories of Canada, Vancouver, B. C.

"Charcoal Production in Kilns"

Wood Machining

"The Role of Coated Abrasives in a Modern Woodworking Industry"—Clifford Baker, Minnesota Mining and Manufacturing Co., St. Paul, Minn.

"Machining of Particle Board"

Wood Preservation

"Effects of Soil, Moisture, and Aeration Variables on Bioassay by the Soil Block Culture Method"—S. S. Sakornbut and R. J. Balske, Monsanto Chemical Co., St. Louis, Mo.

"Factors Affecting the Soaking Treatment of Basswood at Low Temperatures"—C. S. Walters, University of Illinois, Urbana, Ill.

More Suppliers Sign As Paul Bunyan Sponsors

Nineteen additional wood industry suppliers have indicated interest in sponsoring the Paul Bunyan Smorgasbord and Tour, entertainment highlight of the Eleventh National Meeting June 23–28 in Buffalo, announces Joseph Coufal, chairman for the event. Sponsoring firms will be hosts to meeting registrants and their families at a smorgasbord supper at Brocke Monument Park in Ontario on Wednesday, June 26, and an evening tour of Niagara Falls.

Mr. Coufal invites all firms interested in sponsoring the event to contact him at Gray Products Co., Inc., 924 E. Main St., Richmond, Va.

Firms who have asked to be included as sponsors since January 15 include:

American Cyanamid Co., New York, N. Y.
American Manufacturing Co., Tacoma, Wash.
Borden Co., New York, N. Y.
Carborundum Co., Niagara Falls, N. Y.
Clark Equipment Co., Battle Creek, Mich.
Peter Cooper Corp., Gowanda, N. Y.
Delta Power Tool Div., Rockwell Mfg. Co., Pittsburgh, Pa.
Durez Plastics Div., Hooker Electrochemical Co., North Tonawanda, N. Y.
The Lilly Co., High Point, N. C.
Mattison–Greenlee Service Corp., Rockford, Ill.
Merritt–Solem Div., Solem Machine Co., Lockport, N. Y.
Moore Dry Kiln Co., Jacksonville, Fla.
National Casein Co., Riverton, N. J.
Nicholson Mfg. Co., Auburn, Wash.
Perkins Glue Co., Lansdale, Pa.
Protection Products Mfg. Co., Kalamazoo, Mich.
Standard Dry Kiln Co., Indianapolis Ind.
Timber Engineering Co., Washington D. C.
Yates–American Machine Co., Beloit Wis.

24 Firms Reserve Space for Exhibits at Buffalo

Six more firms have reserved space for the Wood Industry and Suppliers Exhibit to be held in conjunction with the Eleventh National Meeting June 23–28 in Buffalo, according to Russell C. Deckert, Exhibit Chairman. This brings the total to 24 firms reserving space at the exhibit, which will be on the mezzanine floor of the Hotel Statler adjacent to meeting rooms.

Chairman Deckert urges companies who wish to display their products or services to meeting attendees to contact him now at State University College of Forestry, Syracuse, 10, New York, while space is still available.

Firms who have reserved space this month include:

Bauer Bros. Co., Springfield, Ohio
Bahnson Co., Winston–Salem, N. C.
Carboloy Dept., General Electric Co., Detroit, Mich.
Heil Co., Arnold Dryer Div., Milwaukee, Wis.
International Harvester, Chicago, Ill.
Mattison–Greenlee, Rockford, Ill.

See page 41–a for New Product News

Rules Announced for 1957 Wood Award Competition

Six schools have indicated possible entries in the 1957 Wood Award competition, which is open to graduate students in attendance for at least one quarter or semester at any North American university or college between January 1, 1956 and April 30, 1957. Official rules for this year's contest have been announced by A. J. Panshin, chairman of the FPRS Industry-Education Division, and J. F. Koellisch, manager and editor of Wood and Wood Products magazine, sponsors of the awards.

Schools which report students tentatively planning to enter are: University of Michigan, Yale University, University of British Columbia, University of Toronto, Iowa State College, and State University of New York College of Forestry. Some of the tentative subject titles are: The Strength of Glued Timber Lap Joints, Mechanical Properties of Red Oak as Related to Drying, Shrinkage Failures of Wood as Influenced by Temperature and Moisture Content, and Preservative Tolerances in a Group of Wood-Destroying Fungi.

H. C. Moser, Vice-President, Gamble Brothers, Inc., Louisville, Ky., has been named chairman of the three-man judging committee, Dr. Panshin also announced. Other judges are Fred E. Dickinson, Director, California, Forest Products Laboratory, Richmond, Va., and Robert R. Blumenstein, Assistant Director of Research, Timber Engineering Co., Washington, D. C.

Two cash awards and certificates will be given for papers based on research conducted by graduate students. The first place winner will receive $350 and second place, $150, with the awards to be presented at the FPRS Eleventh National Meeting June 23–28 in Buffalo. The winner of the first award will be invited to present his paper at the Buffalo meeting.

Deadline for submission of tentative titles is April 15. The complete paper must be submitted in triplicate by May 1 to the FPRS Executive Secretary, Box 2010, University Station, Madison 5, Wis.

New Officers Installed by Pacific Southwest Section

Paul Yankauskas, Sawyer Cabinet Co. was installed as Chairman of the Pacific Southwest Section at the February 13 meeting in the Roger Young Auditorium, Los Angeles. Other officers are: Arthur N. Swenson, past chairman; A. J. Long, vice-chairman; W. E. Ripley, Jr., secretary–treasurer; and Melvin R. Roberts and Robert Blumenthal, trustees.

FPRS Salutes . . .

Men Who Are Contributing Their Time and Efforts for the Furtherance of the Society and the Wood Industry

R. C. Deckert

Russell C. Deckert—Russ is chairman of the Suppliers' Exhibit to be held in conjunction with the Society's national meeting June 23–28 in Buffalo, N. Y. He's in charge of selling and arranging for space for the exhibit at the Hotel Statler. Industry service representative for the State University of New York College of Forestry at Syracuse, Russ is in charge of the college's short courses and aids industry in solution of technical problems. He received B.S.F. degree from the University of Georgia in 1938 and M.F. degree from Duke University in 1943. Russ was with the U. S. Forest Service for six years and an assistant professor at Michigan State College for six years before going to Syracuse.

E. D. Lackey

E. Dent Lackey—The Society is fortunate to have a man of Dent's stature in the public relations field handling local publicity for the Buffalo meeting. Dent is public relations manager for the Carborundum Co., Niagara Falls, N. Y. Formerly public relations director of the War Information Division, Boston Region, U. S. Office of Civilian Defense, and employee relations director of Wright Aeronautical Corp., Dent is a graduate of Oklahoma City University and Boston University.

F. T. Parrish

Frank T. Parrish—Lending valuable assistance in the planning and administration of the meeting in Buffalo, Frank has a long record of service to the Society. He is a former chairman of the Northeast Section and was Northeast regional representative on the Executive Board for two years. A graduate of Wentworth Institute, he is a member of the alumni executive board and trustee of permanent funds. Also active in civic and business affairs, Frank is past president of the Gardner, Mass., Chamber of Commerce and current chairman of its industrial affairs committee, and member of the New England Council Wood Industries steering committee. During World War II he was a consultant for OPS and the National Bureau of Standards on consumer durable goods minimum specifications. In 1938–39 he served as consultant to the judges of the Museum of Modern Art contest in New York for the U. S. and 21 South American republics on home furnishings. He has been with the Heywood–Wakefield Co. at Gardner for 29 years, as superintendent for 15 and in charge of design, research and development of consumer goods for markets in the U. S. and Canada for 14 years.

R. C. Gill

Robert C. Gill—Bob is handling registration and ticket arrangements for the Buffalo meeting. A graduate of Duke University where he received B.S. degree in chemistry in 1949 and M.F. degree in wood technology in 1950, Bob is in charge of wood adhesive development and woodworking technical service for the Peter Cooper Corp., Gowanda, N. Y. The author of trade articles and company bulletins, he is a member of the Society of American Foresters as well as FPRS.

K. O. Roos

Kenneth O. Roos—Ken is chairman of the FPRS Eastern Canadian Section which is cooperating in staging the Society's Buffalo meeting. A leading figure in the Canadian wood industry, Ken is vice-president and general manager of Booth Lumber Ltd., Tee Lake, Quebec. He received a B. Com. degree from the University of Toronto in 1927 and became a chartered accountant in Ontario five years later. He is past president of the Canadian Lumberman's Assoc.; member of the advisory committee on forestry, Ontario Research Foundation; member of the executive committees of Quebec Forest Industries Assoc. and Ottawa River Protective Assoc.; and director of the Quebec Lumbermen's Accident Prevention Assoc.

A. T. Howse

A. T. Howse—Howse is assisting with local arrangements for the Buffalo meeting as transportation chairman. He joined the Carborundum Co. at Niagara Falls, N. Y. in 1924 as assistant to the sales manager and is now the manager of sales administration, Coated Adhesives division. Active in both business and Masonic organizations, Howse is a member of the Coated Adhesives Manufacturers Institute, New York City, and Ismalia Temple, Buffalo. He is a graduate of Provincial Teachers College, London, Ontario.

Plans Announced for Building Fund Drive

National Meeting in Buffalo Set As Target Date for Completion of Campaign

The FPRS Executive Office Building Program was the subject of a special meeting of the Society's Executive Board held January 29 in St. Louis, Mo. President Ralph H. Bescher called the meeting in order to approve final architectural plans for the proposed building and to develop a program to obtain the necessary funds.

The Fund Raising Committee will be headed by Raymond H. Berry, Southwest Regional Board member. He will be assisted by the other five regional Executive Board members, who will call upon section officers in their regions to assist in the program. The Eleventh National Meeting in June, 1957, has been set as closing date for collecting funds.

A brochure outlining the history of the building program, the present need, estimated costs, and description of the proposed building is being prepared by the Executive Secretary. This report will be mailed to members near the end of March. In addition to this, a full report will appear in the March issue of the FOREST PRODUCTS JOURNAL.

A convenient Contribution or Pledge Card appears below for those who have not as yet made a contribution and desire to do so. The Fund Raising Committee points out that every contribution is welcomed, regardless of amount.

The Board expresses its appreciation for the enthusiasm members have shown already in the proposed building, reflected in the more than $2,000 received to date in pledges and cash donations. The list of donors since January 1 includes:

Anderson, L. W., Clinton, S. C.
Androc Chemical Co., St. Louis Park, Minn.
Armbruster, Fred R., Seattle, Wash.
Barkey, L. M. Warsaw, Ind.
Bergstrom, R. H., Hartford, Conn.
Bescher, R. H., Pittsburgh, Pa.
Bock, L. H., Shelton, Wash.
Bovay, H. E., Houston, Texas
Box Planing Mill & Store Fixture Co., San Angelo, Texas
Brandstrom, Axel J. F., Bellingham, Wash.
Brockschmidt, K., Sheboygan, Wis.
Bruce, H. D., Madison, Wis.
Buss Machine Works, Holland, Mich.
Calderwood, H. N., Madison, Wis.
Canton Lumber Sales Co., Minneapolis, Minn.
Carr, J. H., Jr., Washington, D. C.
Cascade Lumber Co., Yakima, Wash.
Champagne, E. Garth, Columbus, Ohio
Cich, Chester, Milwaukee, Wis.
Clairmont, A., Montreal, P. Q., Quebec
Colgate, Robert B., Huntington, Long Island, N. Y.
The Collier Co., Everglades, Fla.
Copp, D. N., Memphis, Tenn.
Core, Harold A., Syracuse, N. Y.
Crawford, Thomas F., White Plains, N. Y.
Deleth, Ir. H. Ernst., Doetinchem, Netherlands
Eason, W. Jeter, Memphis, Tenn.
Erickson, Harvey D., Seattle, Wash.
Farlinger, Ernest, Sioux Lookout, Ontario
Follett, W. E., New Westminster, B. C.
Franciosi, Giovanni F., Napoli, Italy
Garlick, Gardner G., Kalamazoo, Mich.
Gates, E. C., Fordyce, Ark.
Georgia-Pacific Corp., Savannah, Ga.
Gill, Ronald B., Jersey City, N. J.
Gourdeau, Eric, Boischatel, Quebec
Grondal, Bror L., Seattle, Wash.
Gulf Red Cedar Co., Inc., Richmond, Va.
Gurvitch, J. E., Springfield, Mass.
Halsted, Irving L., Scottdale, Pa.
Hauter, J. Allan, Oradell, N. J.
Herrick, Franklin W., Shelton, Wash.
Hiller, Robert L., Hartland, Wis.
Hirsch, Martin H., East Arlington, Vt.
Ivory Pine Co. of California, Dinuba, Calif.
Jamestown Lounge Co., Jamestown, N. Y.
Jewett, G. F., Jr., Lewiston, Idaho
Jones Tie & Lumber Co., Inc., Olympia, Wash.
Kaufert, Frank H., St. Paul, Minn.
Kitazawa, George, Fairless Hills, Pa.
Koehler, Arthur, Vancouver, B. C.
Korodi, Josef, Prince Albert, Sask.
Kreienbaum, C. H., Union, Wash.
Larson, W. E., Grand Rapids, Mich.
Lindgren, Ralph M., Madison, Wis.
Arthur D. Little, Inc., San Francisco, Calif.
Lockard, C. R., Upper Darby, Pa.
Loughead, Harvey J., Asheville, N. C.
Lumber and Builders Supply Co., Solano Beach, Calif.
C. F. Martin & Co., Nazareth, Pa.
Mill Equipment Inc., Seattle, Wash.
Miller, Joe H., Azusa, Calif.
Mitchell, L. O., Forest Park, Ill.
Monsanto Canada, Ltd., Vancouver, B. C.
Neils, Paul, Portland, Ore.
Nickey, S. M. Jr., Memphis, Tenn.
Northcott, P. L., Vancouver, B. C.
Norwich University, Bureau of Industrial Research, Northfield, Vt.
Oehlerich, Harold A., Eugene, Ore.
Olson, A. W., Missoula, Mont.
Pagel, Horst F., Palo Alto, Calif.
Paul, Benson H., Madison, Wis.
Purcell, Robert C., St. Paul, Minn.
Putman, R. B., Pittsburgh, Pa.
Reckers, Cornelius, Olympia, Wash.
Recknagel, A. B., Ithaca, N. Y.
Redman, Kenneth, High Point, N. C.
Richolson, Jerome M., Orange, N. J.
Roberts, J. R., Longview, Wash.
Rogers, James G., Marion, Wis.
Roth, Victor S., Oakland, Calif.
Rovsek, Frank J., Madison, Wis.
Rudnicki, J. M., Ottawa, Ontario
Rush, Robert H., Hawkinsville, Ga.
Sand, Robert M., Cayuta, N. Y.
Seattle Cedar Lumber Manufacturing Co., Seattle, Wash.
Siren, R. O., Ridley Park, Pa.
Skytta, Ernest M., Seattle, Wash.
Smith, C. E., Blind River, Ontario
Smith, N. W., Memphis, Tenn.
Sullivan, James W., San Diego, Calif.
Tegge, A. R., Chicago, Ill.
Turner, Ben M., Cordele, Ga.
Valdosta Plywoods, Inc., Valdosta, Ga.
Van Beckum, William G., San Francisco, Calif.
Van Epps, Clarence F., Rochester, N. Y.
Vaughn, H. E., Reno, Nevada
Warner, W. R., Warren, Ark.
J. W. Wells Lumber Co., Menominee, Mich.
Wellwood, R. W., Vancouver, B. C.
Wilson, R. O., Memphis, Tenn.

CONTRIBUTION OR PLEDGE CARD

Name ----------

Address ----------

I hereby (contribute) (pledge) my support to the proposed FPRS Executive Office Building to be erected as early as possible, consistent with conservative business practice, in Madison, Wisconsin.

(Check here for Contribution and enclose check or money order) ☐ $----------

(Check here for Pledge. We will invoice you for the amount of pledge during calendar year 1957) ☐ $----------

Signed ----------

Madison Selected for FPRS Twelfth National Meeting

Site of the Twelfth National Meeting of the Society, to be held June 22-26, 1958, was changed from Milwaukee to Madison, Wis. at the recent meeting of the Executive Board in St. Louis, Mo. The Lorraine Hotel will be meeting headquarters.

Madison, with its outstanding natural beauty and fine convention facilities, is well equipped to serve as host for the 1958 National Meeting. Location of the FPRS Executive Office, Wisconsin's capital city is also the home of the U. S. Forest Products Laboratory and the University of Wisconsin.

Robert L. Hiller, North-Central Regional Board Member, will be general chairman for the meeting.

Officers Installed at Pacific Northwest Section Annual Meeting

NEW OFFICERS of Pacific Northwest Section installed at annual meeting Feb. 4–5 in Tacoma, Wash., were, left to right: John Syme, vice-chairman; G. Eugene Tower, trustee (holdover); R. W. Wellwood, chairman; A. M. Fisken, trustee; W. R. Francis, treasurer. Secretary P. L. Northcott was not present.

QUALITY CONTROL IN MANUFACTURE OF BOARD PRODUCTS was subject of panel discussion at Tacoma meeting. Left to right are: G. E. Tower, moderator; N. J. Briggs, J. W. Johnson, B. S. Bryant, D. E. Isaacson, W. J. Runckel, Gordon Borchgrevink, and J. R. Stillinger.

FORERUNNER OF FPRS was Associated Forest Products Technologists, which became Pacific Northwest Section in 1947. Former AFPT members attending Tacoma meeting were, front row: J. E. Lodewick, Bror Grondal, J. W. Mann; back row: J. D. Ritchie, A. H. Rauch, A. L. Mottet, A. T. Walton.

TECHNICAL SESSION PARTICIPANTS on second day of Tacoma meeting were, left to right: R. A. Currier, D. H. Clark, L. C. Pounds, R. W. Wellwood, G. F. Russell, T. E. Batey.

Great Lakes Section Plans Clinic on Plywood Warpage

A plywood warpage clinic is being tentatively planned for the 1957 Annual Meeting of the Great Lakes Section, section officers report following a meeting held Feb. 6 in Grand Rapids.

Subjects suggested for discussion at the meeting include veneer logs, selection and area; manufacture of crossbanding; manufacture of face veneer; drying of veneer; plywood construction adhesives; and cold pressing vs. hot pressing and handling. Grand Rapids and Holland, Mich. were suggested as possible meeting sites.

Northeast Section Plans Fall Meeting in New York

October 31 and November 1 are the dates tentatively planned for the fall meeting of the Northeast Section to be held at Prince George Hotel, New York City. Suggested topics for discussion at the meeting include materials handling and tropical woods, their uses, properties, and availability. Panel discussions will be held at a third session.

Student awards will be presented during the National Business Meeting June 24 at Buffalo. Awards will be given to the outstanding man of all entries, outstanding senior, and outstanding junior.

Five Problem Clinics Planned at Ohio Valley Section Meeting

Practical methods of solving wood technology problems will be sought through interchange of ideas at five round-table discussions at the spring meeting of the Ohio Valley Section, April 11–12 at the Kentucky Hotel, Louisville. The first FPRS meeting of this type to be held, it will consist entirely of group discussions led by wood industry experts.

The meeting will open with registration from 11 A.M. to 1 P.M. April 11. Registration fee for the meeting is $4. Keynote speaker at the opening session that afternoon will be C. D. Dosker, president, Gamble Brothers, Inc., Louisville. Two panel discussions will follow at 2:00 P.M., one on Lumber Drying and Handling and another on Carbide Cutters Use and Maintenance. John R. Young, Oliver Machinery Co. will act as moderator for the latter.

A "Sawdust and Chips" Hour has been scheduled that evening from 7 to 8 P.M. This will be followed by a discussion of Jigs and Fixtures in Woodworking with William Lakamp, Baldwin Piano Co., as moderator.

FPRS PROGRESS on national level was reported by Frank J. Rovsek, Executive Secretary, who gave illustrated talk at banquet of Pacific Northwest Section.

Discussions scheduled for April 12 from 9:30 to 11:30 A.M. include a panel on Particle Board and Wood Core with Carl Seng, Jasper Desk Co., as moderator, and one on Glues and Gluing to be led by Jerome Habig, Jerome Habig Veneer and Lumber. A smorgasbord luncheon at noon will be highlighted by an address by Robert L. Hiller, FPRS Regional Board member. The meeting will conclude with a tour of the H. J. Scheirich plant at 2:00 P. M.

President's Column

PITTSBURGH, PA.—I am pleased to report that all Sections, Divisions and activities of our Society are making good progress. For example . . .

R. H. Bescher

Eleventh National Meeting and Exhibit, Buffalo, June 23–28. By this time you have received the registration forms for what promises to be another record FPRS meeting. You will note that we have scheduled our customary technical sessions on such subjects as composition board, furniture finishing, veneers and plywood, gluing, logging and lumber, seasoning, machining, quality control, utilization and preservation. Looking over the advance program, I note such interesting papers as How to Make a House Outlast a Mortgage, Blister and Stain Resistant Paints, Color Control in Furniture, A Marketing Analysis of the Wood Panel Field, Attaining Greater Logging Safety, Developments Toward Improved Power Chain Saws, Integrated Hardwood Logging, Quality Control in the Saw Mill, Trends in Hardwood Plywood, Plywood Pressing Equipment, End Gluing of Lumber, Air Drying of Southern Pine, Lumber Stacking, Stickers and Related Problems, Costs of Hardwood Drying, Advances in Pine Gum Chemistry, Separation of Chemical Constituents from Sawdust, and Charcoal Production. These are but a few of the more than 50 papers to be presented. I urge our members to attend this important meeting, if possible.

The eight "Reviews of Industry Developments during 1956" contained in this issue are an example of the work of FPRS' 14 subject divisions. They enable a busy executive in any branch of the wood industry to keep posted on the principal developments in his own or related segments of the industry.

Paralleling these illuminating reports is one by our Industry-Education Division on the subject, "Wood Technologists in the Forest Products Industry." Through cooperative effort of industry and education members, this division made a survey of recent graduates in our wood technology schools to ascertain their current industrial progress, fields of employment, evaluation of existing college curricula and potential starting salaries. Questionnaires were submitted to 33 colleges and elicited returns from almost 200 respondents.

Progress of our National Employment Committee. One of its principal programs is student summer employment service. The idea is to start promising undergraduates working at jobs in the wood industry during summer vacations, with a view to both previewing and pre-training them for greater responsibility when they become available to you permanently. As of now, 30 colleges and 45 industrial firms are cooperating on the 1957 summer program. I would like to emphasize to our industry members that if you have a summer job that will offer training now, and anticipate an opening in the future where you will need a technically trained man, this program is a good place to start lining up that future employee. I have found that when you have a trainee two summers or so, you have a more valuable employee in the long run. If interested, get in touch with *Dr. Newell A. Norton,* School of Forestry, Pennsylvania State University, University Park, Pa., or our Executive Office.

On January 29, 1957, I called a *special meeting of our Executive Board* in St. Louis in order to make further progress on our needed Executive Office building. Your Board, after long and serious consideration, has decided to go ahead with this building at the earliest date, possibly 1958, the year we hold our 12th national meeting in Madison, Wis. Very shortly you will receive in the mail a special "Report of Progress" on the building and the fund raising program. We have established our goal at $60,000 in contributions, which figure we hope to achieve prior to our National Meeting in Buffalo. We feel we will have no difficulty in raising this sum. We have had very active support from our Sections. In addition, we find that our members at large appreciate the need for this building over that two years ago when we first discussed it at Seattle. Each member will be invited to contribute a sum—the amount of his own choosing—toward the goal. There are numerous reasons why it will be advantageous for us to proceed with this building, and these will be fully explained to you.

I am pleased to report that our first request for your financial support, mailed with your dues invoice January 1, 1957, has resulted in $2,000 of cash donations and pledges. Elsewhere in this issue you will find listed the names of persons and organizations who have generously responded.

RALPH H. BESCHER, *President*

Hardwood Lumber Grading Course Planned at Illinois

Hardwood producers, processors, and distributors will study National Hardwood Grading Rules at the U. of Illinois and Purdue U. hardwood lumber grading short course to be held March 18–22 at the Illinois campus, Urbana. The event is being sponsored by the Coleman Lumber Co., Jonesboro, Ill., and the National Hardwood Lumber Association.

Designed for sawmill managers, lumber scalers, sawyers, and others working with hardwood lumber, the course will include instruction on both manufacture and seasoning in relation to grade. Grading fundamentals will be followed by individual practice grading. Instruction will be given by Leslie A. Parker, assistant chief inspector of the National Hardwood Lumber Association.

EMPLOYMENT SERVICE

Positions Offered

No. E–270—Specialty paper producer in Pennsylvania has opening for engineer experienced in paper production problems. Responsibilities include plant mechanization, introducing new paper products into production. Prefer mechanical engineer approx. 35 years of age. Salary $8,000 to $10,000. (Feb.)

No. E–271—Midwest millwork firm has opening for project engineer to be responsible for design and development of products. Needs man with B.A. in architecture or architecture engineering, interest in product design. Salary based on experience and ability; profit-sharing plan. (Feb.)

Employment Wanted

No. 398—Wood technologist with B.S. from Duke University, M.F. to be received in June, seeks position with opportunities for advancement. Background in wood properties, basic chemistry and physics. Age 22, married. (Mar.)

No. 401—Master of Wood Technology graduate, N. C. State College, B. S. in Forestry, V.P.I., desires research, quality control, or production position. Age 25, single. Veteran as of April 1957. (Feb.)

No. 403—Wood technologist — Ph.D. 12 years' experience in industrial pulp and paper research lab and government wood testing laboratory. Prefers moderately sized community in Eastern U. S. (Feb.)

No. 404—Wood technologist, single, age 29, will receive Masters degree from Yale University in June, seeks employment in field of plywood, particle board or hardboard. Prefers position in production and/or technological research on West Coast. Has good knowledge of quality control and lab techniques. (Mar.)

No. 408—Wood processing and technology graduate. B. S. and M. S., Michigan State University, seeks management position with firm organizing permanent cost reduction program. Five years' experience in operative and administrative management in multi-plant wood preserving company, one year with management consulting firm. Age 30, married, will locate anywhere. (Mar.)

SALES REPRESENTATIVES

Industrial Resins

Several eastern territories. B.S. Engineering or Chemical degree preferred. Thermosetting resins experience desirable. Age 26–35.

Please send complete resume to
Personnel Department

BARRETT DIVISION
Allied Chemical & Dye Corp.
40 Rector Street—New York, N. Y.

Take Your Choice of Any One

When You Join FPRS

A wealth of information on Hardboard, Particle Board or Wood Waste Utilization are yours as an EXTRA BONUS when you join FPRS as a new member. In addition to all the regular Society benefits you may take your choice of any one of these three 48-page booklets—each containing reports presented at recent FPRS meetings—and each illustrated with more than 50 photographs, drawings and tables.

You'll find some of the latest information on economics, tests and evaluation, principal processes, market potential.

Or—you may select any one of the five volumes of the Annual Proceedings from 1947 through 1951—each a storehouse of wood technology research information.

Your choice of any one of these eight books PLUS 1—the monthly **FOREST PRODUCTS JOURNAL**, 2—attendance at FPRS meetings from coast to coast, 3—personalized service on your technical questions, 4—contacts with wood experts, 5—employment service, and 6—pride of affiliation—are yours as a member of the 3,500-member Forest Products Research Society.

Write TODAY for your membership application blank and FREE BOOKLET request form to: Executive Secretary, Forest Products Research Society, Box 2010 University Station, Madison 5, Wisconsin.

NOTE: AVAILABLE AT SPECIAL RATE OF $2 EACH TO PRESENT MEMBERS.

LET'S FACE IT...
IMPROPERLY-DRIED LUMBER PRODUCTS JUST WON'T SELL!

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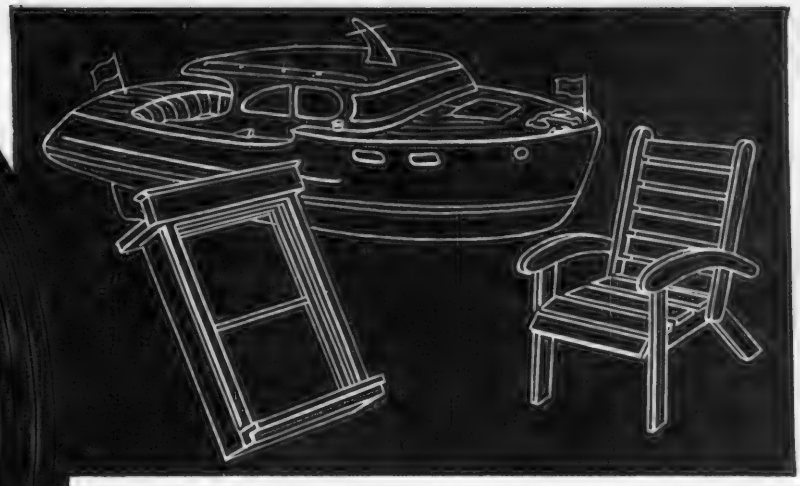

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Carbide Tool Manufacturer Becomes FPRS Supporting Member

Kennametal, Inc., Latrobe, Pa., manufacturers of carbide knives and cutting elements, is one of the newest Company Supporting Members of FPRS. The firm has named Rex V. Reynolds, manager of woodworking sales and head of specialty product sales development, as their designated representative to the Society.

R. V. Reynolds

Mr. Reynolds has been associated with the tungsten carbide industry in production, engineering, and sales work for the past 12 years. Along with his educational background in engineering, Mr. Reynolds has diversified experience in the construction, tool steel, and ordnance felds. He is currently a member of the executive committee of the Wood Industries Division of A.S.M.E.

The company fabricates thousands of different products for woodworking, machining of metal, mining, and other applications. Principal products in the woodworking field are cutting elements for planers, routers, shapers, and other machines.

Main plant and general offices of Kennametal, Inc., Latrobe, Pa.

Kennametal, a distinctive, powder metallurgy product, was invented in 1937 by Philip M. McKenna, the company's founder and current president. The principal ingredients are tungsten, titanium carbides, and cobalt. These are ground into very fine particles and then compressed into tablets or blanks of the desired shape and size. The blanks are heated in special high temperature furnaces, after which they become so hard that they can only be cut or sharpened with silicon carbide or diamond wheels. The small pieces of Kennametal are then brazed or clamped onto the end of a steel shank and the cutting edge ground.

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FPRS Annual Review

Forest Products in Review

The following special reports are the third FPRS Annual Review of technical developments and trends in major segments of the forest products industry. Prepared by FPRS Subject Matter Divisions, the reports have a two-fold purpose: to keep our members abreast of significant technical changes taking place in a dynamic forest products economy, and to provide a ready reference of selected bibliographies of the outstanding papers and publications by fields.

Special Products Take Hold in the Veneer and Plywood Industry

JOHN D. RITCHIE[1]

Regional Board Member, Pacific Northwest Region

Facing an increasingly competitive market, the veneer and plywood industry looks to modified plywoods to expand uses and to improve return on labor and material. The result is more products specifically designed to fit customers needs than ever before. Progress of Canadian manufacturers paralleling that in the U. S. is fully recognized, although not discussed separately in this report.

LAST YEAR'S REPORT opened with this statement: "In the year 1955, the veneer and plywood industry was dominated by a spirit of optimism." Now, after another year; that optimism remains, but it is tempered by the sobering effect of a soft market which existed throughout most of 1956.

This report of the Veneer and Plywood Division[2] will highlight progress in the field of modified plywoods because, in the face of serious sales problems, both the hardwood and fir plywood industries have demonstrated their determination to uncover new markets by emphasizing special products designed to meet specific consumer requirements.

Few new products can be researched, developed, and marketed all in one year so it is impossible to say that 1956 was the year of revolutionary new ideas. Yet a highly competitive situation usually results in extra attention being given special materials and that is what happened in 1956. The result is that 1956 can be safely labeled the year in which modified plywood products truly "arrived."

Whether hardwood, Douglas-fir, or other western softwood panels, special products offer their own characteristics which set them apart. These may be special decorative qualities, extra durability, unique surface characteristics, special structural properties or panels modified by cutting or shaping to the customer's specifications. Since they are specified for one or more of these special characteristics, they can be sold on that basis and price need not be the number one consideration—an important advantage to the manufacturer in a highly competitive situation. In addition, the manufacturer finds that the modified plywoods give him a better return for raw material and labor expended and they open new opportunities because of the special characteristics not present in standard products.

The Hardwood Plywood Institute reports that market consumption of hardwood panels has increased by more than 50 per cent since 1950. Yet, domestic industry has not enjoyed this growth pattern due to the flood of cheap import plywood, particularly from Japan. So the hardwood plywood industry has an added reason for developing special products to help offset the inroads of foreign competition.

Now approximately one-third of the industry's production is in the form of modified plywood products. There are some 21 classifications in this field, the fastest growing specialty being prefinished hardwood plywood paneling. Developments in curved and formed panels have expanded also, and a substantial volume of material is now going into impregnated laminates and high density dye blocks and dye boards. Prefinished plywood floor blocks is a rapidly developing market utilizing oak, maple, and pecan veneers. Specialized markets are also being uncovered in the transportation field, marine uses, and in fire-resistant applications in millwork and furniture.

While prefinished hardwood paneling is the fastest growing specialty, it is interesting to note the emphasis placed on pre-cut products, machined plywood parts (shaped), laminated materials, and other specially fabricated items. That these modified plywoods amount to one-third of total production is an astonishing fact in view of the volume of hardwood plywood manufactured.

Figuring all production, 130 hardwood plywood mills produce approximately 900 million square feet of market plywood. An additional 350 million square feet is produced and con-

[1] The author wishes to thank H. O. Fleischer, Chairman of the Veneer and Plywood Division; John H. Huling, Fine Hardwoods Assoc.; and John Butler and R. D. Behm, Hardwood Plywood Institute; for their generous assistance in preparing this report.

[2] Steering committee members are: J. S. Bethel; J. Butler, R. W. Peterson, John D. Ritchie, J. R. Roberts, C. H. White, and H. O. Fleischer, chairman.

The Author: John D. Ritchie is Special Products Director at the Douglas Fir Plywood Association, Tacoma, Wash. He attended the University of Washington and has served in various capacities with the D.F.P.A. during the past 21 years.

sumed by mills with combination facilities. In addition, hardwood plywood container and packaging plywoods amount to about 250 million square feet, making a gross industry volume of 1.5 billion square feet. The industry presently is producing at approximately 70 per cent of capacity so there is room for further market expansion and for the development of even more special products.

Fine Hardwoods Manufacturers Turn To Beautyguard

To protect present markets and to attack new ones, the manufacturers of fine hardwood panels are turning to the Beautyguard process. This was announced about a year and a half ago and, at the end of 1956, 15 furniture and 13 panel manufacturers in the United States and Canada were producing Beautyguard. Many other firms are making plans to put it into production soon.

What is the Beautyguard process? Briefly, it consists of: (1) bonding specially processed aluminum foil under the face of a genuine hardwood plywood panel to rapidly dissipate surface heat, and (2) the use of approved resistant finishes, which prevent surface damage from cigarettes, alcohol, and other abuses.

Beautyguard offers these advantages:

1. It enables the use of beautiful hardwood surfaces on heavy duty areas (such as table tops, desk tops, dresser tops, bar tops, counter tops, etc.) rather than substituting other materials.
2. It makes possible the production of burn and stain resistant genuine hardwood surfaces at lower cost than using plastic laminate surfaces.
3. It gives any heavy duty hardwood product or surface more eye appeal and greater sales appeal because this surface is actually of the fine hardwood and not a covering of protective film or coating which can detract from its original natural beauty.

The Beautyguard process has been developed over a period of years by several different agencies. However, the Fine Hardwoods Association has conducted and co-ordinated the more recent research and development work which now makes the process practical in plant production. It is interesting to note also that, through the Fine Hardwoods Association, the Beautyguard process is available to anyone without fee, royalty or charge of any kind.

Fig. 1.—Laying Beautyguard test panels prior to production run. Low-temperature, hot press system.

Ever-Increasing Fir Plywood Production

While hardwood plywood manufacturers look to special products to help expand markets and combat foreign competition, the primary problem of the Douglas-fir plywood manufacturers seem to be to find a place for continually expanding production. Here, special products provide one answer at least. They reduce the total amount produced in standard grades which may be in over supply because they provide a more profitable outlet for the same veneers. Production of specialties generally will reduce the manufacturer's over-all volume and yet give him an adequate return for footage manufactured. Thus, by opening new market opportunities with their unique properties and by reducing total footage produced, the specialties play a part in the necessary balancing of production and sales.

The history and growth of the fir plywood industry is reported too often elsewhere to justify going over it again here (see TIMBERMAN, January 1957). Suffice it to say that production and sales in 1956 reached a record total of 5.25 billion square feet,[3] yet capacity increased to 6.25 billion square feet annually. So, despite record production, record sales, and substantial progress in new markets, 1956 was not a good year for fir plywood. "The market was off."

1956 A Record Year For Fir Plywood Specialties

On the plus side, however, these are the conditions under which special products receive deserved attention and, in 1956, they solidified their position to a point where they probably never again will fall back.

[3] Measured on a 3/8-inch thickness basis.

Despite a soft market in standard grades, 1956 was a record year in fir plywood special products — approximately 125 million square feet (other than hardwood faced panels). Due to the tremendous volume of total plywood production, the percentage figure will probably always look small, yet the amount in square feet is substantial and already has made a tremendous impact on the trade.

In contrast to the hardwood industry, fir plywood manufacturers do not deviate very far from standard practice to produce modified products. They come in standard sizes and thicknesses and are manufactured on equipment already set up for regular production. This probably over simplifies the situation because extra processing obviously is required. Yet fir plywood specialties remain high volume items, much less exacting than those which demand special plans, special crews, extra precision equipment, controlled atmospheric surroundings, etc.

2·4·1

The one fir plywood specialty introduced for the first time during 1956 is 2·4·1, a single thickness of fir plywood which serves two uses—structural subfloor and underlayment. It is engineered to function as a solid one-piece base over supports of 48-inch centers for everything from thin vinyl tile to oak strip flooring. It is a good example of a special product which offers important structural economies.

2·4·1 is an unsanded 1⅛-inch panel, having at least seven plys. Face and back veneers must be Douglas-fir but inner plys may include other western softwoods. It is an excellent example of combining lower grade veneers and combinations of western softwoods into a structural panel of extra value. Production is increasing each month and presently 42 manufacturers are set up to make 2·4·1.

Texture One-Eleven

Texture One-Eleven, still a new product in the field, continues to improve its position as a combination siding and sheathing and as an accent panel for both interior and exterior uses. Total footage did not expand under 1956 conditions, but the number of manufacturers increased from 10 to 17 and markets spread out from a limited number of large tract builders and prefabricators to a wide range of smaller users. At the same time, a much greater variety of applications has increased the possibilities of establishing Texture One-Eleven on a permanent basis.

This product couples high style and low cost in one panel. It draws its

visual appearance from the striking combination of line and texture in tune with current architectural style trends. It is 5/8-inch thick and five plys of C-grade throughout. Only the face is upgraded to provide a natural C-grade rather than to admit any repairs. The surface is unsanded.

Texture One-Eleven allows the architect to achieve handsome new siding effects at surprisingly low in-place costs for all types of homes, shops, motels, offices, and other forms of commercial buildings. The panels are grooved every two inches or four inches and, since the groove is a quarter inch deep, 3/8 inch of solid panel remains. This allows for application directly over studs without the use of sheathing—another important saving to the builder.

During 1956, Texture One-Eleven was made available in other western softwoods than Douglas-fir and in other than standard groove spacing on special order, all of which further broadens the potential for this specialty.

Overlaid Plywood Uses Expand

Two well-established specialties come under the heading of overlaid plywood. These products have been described many times before but, even more than some of the other modified products, they seem to have caught hold in 1956. Both are exterior plywood throughout with phenolic resin impregnated paper surfaces designed for permanent outdoor exposure.

High Density overlaid plywood is an industrial panel most familiar in natural translucent color, but an increasing amount of olive drab and black has been specified during 1956. The surface is highly resistant to abrasion and to moisture absorption. For this reason, it is usually unpainted and is directed to applications where these are important properties. The number one use thus far is for architectural concrete form work because it produces a uniform, smooth concrete surface, reduces finishing costs, and can be re-used an almost unlimited number of times if cared for properly.

High Density overlaid plywood is also the fir plywood industry's answer to traffic control signs faced with reflective sheeting. Used in this manner, it need not be painted, thus effecting an important saving. This application is increasing steadily and the traffic control sign market will be a top priority objective during 1957.

Medium Density overlaid plywood is designed first and last to be a superior paint surface. It is opaque and hides patches and other surface irregularities which may be objectionable in regular exterior fir panels. Exterior siding is probably the number one potential for Medium Density overlaid plywood. Here all of the well-known advantages of plywood can be exploited with the long lasting smooth paint surface added. As well as for such flat panel uses as soffits, gable ends, and accent panels, Medium Density overlaid plywood is being strongly promoted as a precut lap siding—even beveled siding.

Fig. 2.—New structural panel called 2.4.1 is a combination subfloor and underlayment panel which goes over a floor framing system rapidly. It provides a tight, solid, one-piece base for any kind of flooring finish, from wall-to-wall carpeting to a resilient tile.

Traffic control signs are also a natural for Medium Density overlays. Where reflective letters or buttons are used, the sign must be painted and all of the advantages of Medium Density overlaid plywood become an important asset. As one more important potential, the marine field received a great deal of promotional attention during 1956.

The overlays certainly cannot be considered new in 1956. They probably have been rehashed more than any other fir specialty. At the same time, they are the best example of a special product which is finally coming into its own and making an important place for itself.

Decorative Surfaces and Hardboard Faces

Like most of the other fir plywood modified products, the decorative panels—striated, embossed, brushed—are quite familiar. Also, like the other specialties, they have become more firmly established with more manufacturers taking part and more varied uses being uncovered in 1956 than ever before. Canadian mills have devoted a lot of effort to this type of specialty.

The striated and embossed patterns require top quality fir veneers, but certain grades of brushed panels offer a fine opportunity to exploit other western softwoods and it is possible to get pleasing effects with a limited number of knots and knot holes allowed. Thus, so-called minor species and low-grade veneers are turned into a top quality end product.

Fig. 3.—New overlaid fir plywood panels with special resin impregnated fiber surfaces fused to the panel face are ideal for traffic control signs like these.

A steady but small amount of hardboard faced plywood (Plyron) has been produced for a number of years. Production began to expand in 1956, however, and has now become significant even though the total is still small (approximately 12 million square feet for the year). Eight plywood producers also have hardboard plants and most of these have shown an interest in combining their two products into Plyron. Three of the leaders in this field are responsible for most of the growth in 1956 and can be expected to expand further in 1957. Unlike the other specialties, the hardboard faces in Plyron actually replace fir veneers so a very important raw material saving is effected.

In use, Plyron offers all of the surface characteristics of top quality hardboards plus rigidity and split proof characteristics of plywood. Its early uses have been in cabinet work, built-ins, store fixtures and counter tops. Recently, substantial footage has found its way into flooring as underlayment.

Increased Precutting and Shaping

Finally, fir plywood manufacturers are doing a great deal more precutting and shaping to customers' specifications than ever before. Long a source of irritation because this cutting into small sizes and shapes is difficult to accomplish economically in plants geared for high production items, more mills all the time are setting up specially to accomplish this extra step. This provides an extra profit for the manufacturer and an extra service for the customer.

In reviewing the year, it becomes increasingly more apparent that hardwood and fir plywood producers alike are striving to provide products designed to accomplish new things in new markets. At the same time, they are giving increased attention to the specific needs of their customers.

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Developments in Glues and Gluing

Edited by ALAN A. MARRA

Chairman, FPRS Glues and Gluing Division

A number of segments of the glues and gluing field are covered, including both theory and practice. Discusses trends in adhesive developments, gluing techniques and glued products, test methods, and new equipment. Current research projects in the field are listed.

As reported in the Annual Review for last year, developments in the field of Glues and Gluing do not arise as spectacular new findings, but as slow steps in a broad front of interlocking trends. The field of gluing must not be viewed in the narrow sense as the application of some adhesive substance between two wood surfaces to be joined. This would center interest solely on the development of new adhesives. Actually the field is as broad as the woodworking industry itself.

The types of articles being glued today are countless, and the number is growing. They involve many problems not only in the selection of the specific adhesive system, but also in the seasoning and machining of the wood, equipment used for handling materials and applying pressure, production schedules to be met, and ultimate performance of the product which demands some advance knowledge of the permanence of bonds. Thus there are many avenues for development, and often many facets to a single innovation.

This Annual Review is designed to bring as many fronts into view as possible. The field has been divided into a number of segments embodying not only the practice of gluing but also the theory which, in the form of research, patents and literature, often becomes the precursor of developments. Hence, in a well-informed Society, there exists the opportunity to be ahead as well as abreast of developments. The coverage of each segment has been assigned to an expert and this Review is a compilation of their contributions.

The Author: A. A. Marra holds B. S. and M. S. degrees from N. Y. State College of Forestry, Ph. D. from U. of Michigan. He was associated with Engineering Research Corp., Riverdale, Md.; Pluswood, Inc., Oshkosh, Wis.; and Monsanto Chemical Co. before joining Michigan faculty, where he is associate professor of wood technology.

I. Adhesives

RICHARD F. BLOMQUIST

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For the past several years the number of different types of woodworking glues in industrial use has not changed significantly. There has been a gradual, continuous shift from the older non-resin glues such as animal, starch, casein and soybean, to the newer resin glues including urea-, phenol-, resorcinol-, melamine-, and polyvinyl-resin glues. This shift in emphasis began just before, and continued after, World War II and now appears to have been fairly well stabilized with animal, casein, and soybean glues still being extensively used in some gluing operations; vegetable glues being largely replaced by extended urea resins; and with the newer resins being well established in other applications. There has been a distinct trend towards each glue manufacturer supplying a rather complete line of both non-resin and synthetic resin glues from which he can select and recommend a specific formulation for suitable performance under any one of a number of different applications.

In spite of this apparent stability in the woodworking glue field, there are a number of interesting new glue developments in somewhat limited actual use or on the horizon that are worthy of some mention. In recent years a number of important developments have been underway in other phases of the adhesive industry which are likely to be of some interest in gluing wood to itself and particularly wood to plastics and to metals to produce new composite wood products. Some of the principles involved in developin

these new special adhesives are also likely to be of value in suggesting improved glues for wood to wood.

Perhaps the most important principle here is that of blending two or more different resins or other components together to produce new adhesives that have special improved properties over those of any of the individual components. Earlier applications of such combinations were the urea-melamine resins and phenol-resorcinal resin glues now in fairly general use.

Incorporation of phenol resins or other phenolic components into conventional polyvinyl acetate emulsion glues has shown some indications of improving the creep or cold flow and the relatively low moisture resistance of these emulsion glues while still retaining their convenience and relatively fast-setting characteristics. It would seem that further work along this line would be justified.

Combinations of urea-resin and polyvinyl-resin emulsion glues are increasing in interest and are reported to offer improved ability to wet wood surfaces that are hard to glue, such as certain plywoods, and thus improve the gluing properties of such woods. The combinations offer somewhat greater flexibility in the joint, faster setting compared to straight urea resins, more moisture and temperature resistance than straight polyvinyl-resin emulsions, and are promising for gluing plywood to wood frames as in tops and end panels of furniture.

Another similar combination involves protein glues with certain other resin emulsions and reported to be adaptable for a "no-clamp" pressing process for flush doors. Such glues are said to combine the fast setting of the emulsion glues with the better moisture and creep resistance of the protein glues. These protein-emulsion combinations are also said to bond better to hard-to-glue wood surfaces than are the individual components as glues.

The use of special extenders for phenol-resin glues to produce low-cost glue lines in interior-type softwood plywood continues. Earlier extenders included wood flour and ground Douglas-fir bark. Blood was also used and more recently a residue from the hydrolysis of oat hulls in the production of furfural, known as "Furafil", has been used. The procedures for mixing these extenders with the resin differ somewhat and may require some heating of the extender in alkali before incorporation with the resin. Proportions of extender and phenol resin vary quite widely and in some cases the resin is definitely the lesser quantity.

These various extended phenol-resin glues appear to make satisfactory interior-type softwood plywood when properly used, although they do not meet the exterior type joint requirements where phenol resins with lower proportions of extenders are commonly used.

Cereal flour, particularly wheat flour, continues to be the most popular extender for urea-resin glues in the hardwood plywood field.

A practical cold-press blood glue, that can be mixed easily and used much like a conventional soybean glue, has recently been announced for softwood plywood of the interior type. Previous blood glues in commercial use either required hot pressing to achieve maximum performance or were reported to be difficult to prepare for use as cold-pressed glues. The new cold-press blood glue can be used in the "no-clamp" process like soybean glues.

Liquid animal glues continue to be of interest in the furniture industry, particularly for assembly work, and tend to replace the older hot animal glue formulations. Polyvinyl-resin emulsion glues continue to compete strongly with animal glues for such assembly operations. The choice between these two types of glues is based largely on the speed of set, assembly time tolerance, and degree of stress anticipated on the joint.

The fast-setting contact adhesives based on neoprene rubber dissolved in organic solvents were originally offered as adhesives for bonding plastic laminate sheets to plywood or other bases for table and counter tops, particularly for on-the-job installations. These contact cements continue to intrigue the woodworker and offer some particular advantages in special operations such as bonding thin plywood wall paneling to furring strips in remodeling, where freedom from nailing is important and where stresses on the joints are not likely to be severe.

Contact adhesives do not yet provide joints of high strength, sufficient to develop the strength of the wood as is often desirable, and are not currently feasible where thick glue lines are required. They are finding increasing application in attaching thin wood or metal facings to hollow-cores in certain types of sandwich panels. The permanence of the resultant joints under more severe service and their freedom from creep under continued load are factors which will require further study before such contact adhesives can be safely used in the more critical applications such as stressed-cover house panels.

Epoxy resins, based on condensation products of bisphenol or other hydroxy compounds with epichlorohydrin, were first used as paint finishes and since have become important adhesives, particularly for metals in the aircraft industry. These resins combine remarkable adhesion to a number of different surfaces including wood, metals, certain plastics and even glass, with 100 per cent chemical reactivity making them potential contact adhesives or adhesives requiring only low gluing pressures. Since they contain no water or other solvents, they hold promise for bonding materials where such solvents lead to trouble in the gluing operation.

A good deal of effort is being directed towards developing both better and lower-cost epoxy resins and better curing agents to produce effective thermosetting even at normal room temperatures. At present these epoxy resins are essentially specialty adhesives in the wood industries, such as for laminating impreg lumber for die model stock or bonding wood to other materials. However, wider use can be expected later as these resin developments continue.

Adhesives or binders for wood particles in the particle board industry continue to require extensive experimental development. At present both phenol and urea resins are used. Although the resins themselves are basically similar to those in the corresponding woodworking glues, the actual formulations are necessarily different to provide the combinations of handling properties for the particular plant processes, durability, and economy required.

Polyvinyl-resin emulsion glues have been adapted for a "no-clamp" process similar to that used with soybean glues, and such processes are being used both for production of flush door and plastic laminate-plywood table tops.

Special phenol resins have been developed for a new rapid technique of laminating 2 x 4's utilizing an old principle of thermosetting-resin glues. Here both wood surfaces are first heated to 300° F. or thereabouts to provide the actual heat needed to cure the resin, after which the glue is rapidly applied to these hot surfaces and the joints rapidly clamped for a brief period on specially-designed production equipment. The problem here is to achieve very rapid curing under brief pressure, without encountering precuring and other problems.

Adhesives of the contact type have been successfully applied to veneer strips to permit the rapid bonding of such edge-banding to plywood and other panels much like the application of pressure-sensitive tapes. At present the product is rather expensive and

therefore limited to special applications where convenience and simplicity outweigh the higher cost compared to conventional edge-bonding techniques.

Adhesive developments continue in the wood industry and in various allied fields. Both the fabricator and user of glued wood and composite wood items are continuing to develop greater confidence in the ability of the glue to hold the individual components together satisfactorily over the life of the article. New types of glues are being offered to the "do-it-yourself" addict through local retail outlets. With adequate care to encourage proper gluing conditions, glues should continue to merit this confidence in their ability to perform so well that the glued joints can be neglected as a factor of concern by the ultimate consumer of a glued article. It is likely that each year new adhesive developments will be offered. The developments will quite likely be evolutionary rather than revolutionary.

II. Gluing Techniques and Glued Products

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There is increasing use in the East of the recently introduced cross-fed veneer splicers under the trade names of Torwegee and Fischer. These splicers are considerably faster in operation than the conventional Diehl veneer splicers, but are less suited to matching veneers for case goods tops, fronts, etc. than the Diehl and Plycor type machines. To date their use has been confined to the splicing of industrial plywood faces and all types of crossbanding, veneer core stock, etc. As to the adhesive these machines will handle, initially polyvinyl acetate emulsions were recommended; however, urea formaldehyde resins plus some filler and the correct hardening salt perform satisfactorily.

Reductions in clamping times have always been a source of fascination for cold press users. In plywood manufacture this trend led to the development of the "no-clamp" process, used originally for soybean glues. Today resin adhesives alone or in combinations have permitted a marked broadening of the situations where "no-clamp" gluing can be carried on.

In the fabrication of exterior doors, both hollow-core and flush, fortified urea resins are finding increased acceptance. Urea resins are normally fortified with melamine for hot pressing high-durability plywood. Cold pressing similar quality urea bonds in doors has been made possible through the use of a special fortifying modifier. This modifier imparts a marked improvement in water resistance and boil resistance over a conventional urea resin; however, it falls somewhat short of a true boil-proof glue line.

On the whole, laminated timbers are markedly expanding in use mainly through the efforts of the American Institute of Timber Construction. The importance of the use of a truly durable adhesive in their fabrication cannot be over-emphasized. The primary objection raised is "too high glue-line cost". However, adhesive manufacturers are making good progress in the perfection of lower cost resorcinol-phenol blend type adhesives, with appropriate extenders and modifiers that essentially place this group of durable adhesives close in cost and use characteristics to highgrade casein glues.

Assembly gluing is undergoing a period of experimentation trying out some of the newer ready-to-use adhesives to see whether advantages exist in particular cases. Today there is more and more use of the separate application catalyst, or hardening salt, in the use of urea formaldehyde resins in this type of operation. Time has proven, in the opinion of the author, that the low pH of the glue line is not as detrimental to the wood, where same is in a large body, as was initially considered. Certainly one cannot beat the speed of a properly selected separate application catalyst in cold pressing, and apparently the extra cost in applying the two mediums is offset by the extended liquid life of the adhesive and no premature jelled mixes.

Particle board binders are perhaps receiving the most concerted development in their short history. Since so much of the commercial success of particle boards depends upon the binder, particularly its cost and its bonding properties under critical conditions, the advancement of this element of the process is being watched with a great deal of interest. What is desired is a low cost, high durability binder which can be applied without the introduction of solvent. Some progress in this direction is already on the horizon. In the meantime, improvement in urea resins specifically designed for the purpose are finding their way on the market. One recent formulation requires no catalyst addition and exhibits practically no objectionable formaldehyde fumes during use.

The bonding of decorative plastic laminates to plywood has developed a trend toward the use of intermediate temperatures (mild hot-pressing) for curing the adhesive. A urea resin-cold press catalyst combination is used, and a platen temperature usually just under 200° F. This results in considerably greater speed of operation, and avoids the serious compression in the press which is responsible for a degree of telegraphing.

Gluing reaches its greatest height in the bonding of structures containing different materials such that each component contributes its best properties. Aluminum foil bonded to balsa wood is an outstanding example of combining properties, in this case producing amazing strength per unit of weight. The combination of hardboard and veneer, overlays and veneer, chipboard and veneer, overlays and chipboard, and overlays and lumber are areas of fast increasing interest. The use of paper overlays on lumber are said to upgrade the lumber, as well as significantly increase its dimensional stability and paintability.

III. Methods of Test

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Reliable test methods are the mainstay of the use and manufacture of adhesives. They are needed in the development of adhesives, in the evaluation of their handling properties, in studies of adhesion characteristics of wood, in controlling bond quality under production conditions, in predicting performance, and in showing conformance to purchasing specifications. The importance of test methods is reflected in the amount of research devoted to this phase of the field, as can be seen in a subsequent section on research.

Recognizing the importance of adhesive test methods, the American Society for Testing Materials organized a special committee, D–14 on Adhesives, to deal with the problem. The current chairman of this committee is Dr. Richard F. Blomquist, author of the first section in this Review.

Among the tests which are receiving increased attention are delamination tests of plywood. These tests have two principal limitations: (1) long time required and (2) great variability in the results. Progress in the reduction of testing time has been made through the use of more severe exposure conditions. The control of variability is largely a statistical problem of sampling. Improved sampling techniques are being suggested for all test methods.

Test procedures have been developed and published for most properties. However, evaluation of the methods and further refinements are continuing in every direction. As these methods become standardized and put into general use, results obtained by

one researcher can be more confidently used by another to supplement his own data. Moreover, there will then exist a sounder medium of communication for stating quality of adhesives and glued products. A logical and desirable consequence is already in the making, namely, an increasing awareness among glue users that certain properties are responsible for particular adhesive behavior. Purchasers should eventually be more specific in their stated requirements.

IV. Gluing Equipment

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Gluing equipment often evolves in response to special demands for using certain types of adhesives in certain constructions. Thus equipment development often follows rather than precedes other developments in the field. For this reason, also, gluing equipment may acquire narrow regional utility rather than national importance. Most of the items mentioned in this section pertain mainly to the Pacific Northwest. They are, however, of wide interest and many may be adaptable elsewhere.

In the field of glue mixers, three developments appear to warrant consideration. One is the increased use of heating and cooling jackets for greater flexibility in preparing low cost mixes. Another is the introduction of reinforced (glass fiber or neoprene) scraper blades on agitators to scrape sides of mixer clean for better mixing and better heat transfer. Reductions in cooking time up to 50 per cent are reported for preparing hot mixes. A third is increased interest in a high speed, propeller type mixer for cold protein mixing. One 1500 lb. mixer uses two 10-inch marine-type propellers turning at 400 RPM.

Mechanical spreaders have also received some attention. An improved rubber formulation for the rolls has been compounded using a Buna-N type material. Better cutting property and good wearing is achieved, as well as resistance to swelling. It is reported to be extremely easy to keep the grooves clean.

The Lawrence spreader which uses compressed air for maintaining roll pressure is gaining wider acceptance in the softwood plywood industry. More uniform spreading of wavy and rough stock with less glue waste is a feature of this spreader.

The trend in presses is toward both larger and smaller units. In the West, 25-opening presses are appearing and they will spawn other trends such as counterbalanced press platens and increased interest in loading and unloading equipment. A Lawrence unloader allows hand loading of press while it is being automatically unloaded. This is valuable in operations not using automatic pre-loader which has been a source of difficulty at times. In many cases unloading equipment has been mill-designed for a particular installation.

Elsewhere, a need for smaller and simpler presses has been met by the single and double opening hot presses, and the overhead hose-operated cold presses designed for package loads where the head travel can be kept within two to three inches. Similar presses requiring further head travel are supplied with sectional heads containing small overhead rams.

An interesting attachment has become available for converting single or double opening hot presses into batch type clamps for edge-gluing lumber.

Two developments controlling the moisture content of stock for gluing should be mentioned. One is the direct-fired drier using either oil or gas which has been looked upon with interest because of the greater efficiency offered. Direct firing seems to be satisfactory where temperatures are kept below 400° F. on Douglas-fir. Over-heating of veneers leads to gluing difficulties.

Continuous, 100 per cent inspection of stock to be glued is receiving increased attention. Few variables exert as strong an influence on the quality of bonding under production conditions as wide variations in moisture content of the wood. Equipment which automatically provides security against the use of unfit stock is an important contribution to the advancement of wood gluing.

V. Current Research

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Activity on the research front reflects the wide interest existing at all levels of research from molecular considerations to design of glued constructions. Research is being carried on by many organizations and individuals, and it is virtually impossible to survey the entire effort.

Perhaps the best assessment of the work in progress is provided by the National Lumber Manufacturers Association in their "1956 Survey of Current Research of Interest to the Forest Products Industry of the United States." The following list of projects and organizations has been extracted from that publication and is published with their permission:

1. Development of improved wood adhesives.
2. Development of water-resistant and waterproof adhesives.
3. Studies of adhesive formulations for the potential fast-setting bonding of wood and wood-base materials.
4. Development of binding and coating resins for wood-based products.
5. The utilization of animal glue for use as bonding agents in the manufacture of wood products.
6. Study and development of adhesives for packaging and packing of items for overseas shipment.
7. Development of adhesives and techniques for high-frequency gluing.
8. Evaluation of processing variables in high frequency gluing of hardwoods.
9. Radio frequency power required for curing glue joints.
10. Factors affecting the quality of an epoxy resin wood-to-wood bond.
11. Factors affecting adhesion.
12. Investigation of the fundamentals of adhesion and the mechanisms of deterioration of adhesive bonds at high temperatures.
13. Methods of testing adhesives.
14. Influence of additives on the water-resistance of soybean adhesives.
15. A study of some factors affecting the gap-filling properties of selected wood adhesives.
16. The influence of surface exposure on glue bond strength.
17. The sensitivity of glue bonds to rate of load in testing.
18. Studies of potential accelerated performance tests of glues.
19. Development of improved methods for testing resorcinol-phenol wood laminating adhesives.
20. Procedures for measuring the mold resistance of protein glues.
21. Studies of the creep properties of polyvinyl resin emulsion and animal glues.
22. Effect of tension wood on glue joint strength.
23. Survey of strength tests of glue joints.
24. Hot-pressing Douglas-fir plywood with high moisture content veneer.
25. The bonding characteristics of various adhesives in relation to species variables such as density, texture and extractive content.
26. Effect of moisture content on the performance and appearance of resin glue lines in laminated oak lumber.
27. Investigation of the preheat technique for commercial laminating of 2 x 4's.

28. Studies of the gluing properties of California hardwoods.
29. Investigations of more efficient means of testing wood laminates.
30. Laminating and gluing Rocky Mountain species as a means of better utilizing small timber.
31. Determination of minimum bending radii for woods commonly used in curved glued laminated members.
32. Development of suitable techniques for laminating six types of tropical woods.
33. Investigations of the yield of laminating grades of lumber from various commercial grades of white oak.
34. Investigations of Douglas-fir laminated fiberglass sandwich aircraft carrier decking.
35. Studies on laminating preservatively treated wood.
36. Studies of the laminating and steam bending of preservative treated red oak.
37. Design and development of laminated wooden springs.
38. Evaluating paper-overlaid lumber and the performance of overlays in masking defects in plywood.
39. Design and development of end joints for southern hardwoods.
40. Design and development of end joints for southern pine lumber.
41. Factors influencing adhesion in furniture joints.
42. Development of end joints for lumber.
43. Development of plane corner joints of high strength.
44. Studies of the relationship between wood structure and properties on the tensile strength of glued scarf joints.
45. Determination of the durability of scarf joints produced by high frequency gluing in white oak laminations.
46. Development of service records of the durability of glue joints in laminated wood structural members.
47. Development of economical methods for producing acceptable scarf joints in thin laminations.
48. Determination of manufacturing techniques for the production of marine type veneer and plywood from tropical woods.
49. Glueability of Douglas-fir veneer dried at high temperatures.
50. Determination of the cause of the development of latent surface defects in tupelo gum plywood panels.
51. Evaluation of synthetic rubber caulking materials as double-plank sealants for wooden hulls.
52. Studies of the fitness of white speck veneer for the production of plywood.
53. Determination of the mechanical properties of white speck wood or plywood.
54. Compression of white speck Douglas-fir veneers during hot pressing.

Use of Statistical Designs Increases

In the adhesive research field, a small revolution has been in progress for several years. This involves the increased use of statistical concepts in organizing research projects. The result has been greater efficiency from research effort, and greater confidence in the results. One of the major obstacles to wood adhesive research has been the large number of factors which affect the quality of a joint, and the unusually large uncontrolable variations which occur in the data. Statistical designs are becoming more popular as a means of circumventing these obtacles. Variations in bond strength observations due to variations in the wood, for example, need not affect an important comparison one may wish to make between two glues or two treatments.

Perhaps the most gratifying aspect of the research scene is the proportionately large number of fundamental studies being carried on by both public and private institutions. More and more interest is being shown toward the "why's" of adhesion as well as the "what's". Spectacular new developments await the development of more knowledge concerning the actions which transpire in the formation of a bond between two surfaces, and the factors which influence these actions.

VI. Patents

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Although much of the progress enjoyed by the wood gluing industry has come about through practical experience, many key break-throughs have been made as a result of free enterprise. These advances often are patented, and hence the patent literature becomes a source of information on the very latest developments. This section will carry from time to time the important patented innovations occurring in the past year.

VII. Bibliography

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As important as the developments themselves are the written accounts of them. A main problem in the field of glues and gluing is that of education and dissemination of information, and the attendant problem of compilation and classification of knowledge. This section has the task of compiling the significant literature references existing in this field. When this has been done and published in a future Annual Review, subsequent reports will contain only the important contributions of the previous year.

Conclusion

This Annual Review has covered a wide gamut of activity. It has by no means included all the developments which have occurred in the recent past. A more complete coverage would require the combined efforts of a small army. It appears appropriate to close this Review with an appeal for at least a battalion.

Nothing spurs an industry like a fresh idea from another industry or another part of the country where other brains are independently wrestling with problems based upon similar principles. Anyone reading this Review who derives from it a sense of incompleteness, a feeling that something has been left out, is invited to join up. Contribute that something. If enough people can be impelled by the same feeling, next year's Review will most certainly approach closer to its objectives.

Developments in Logging—1956

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Fuller utilization of trees cut is resulting from increased chip use, integrated logging, and development of new equipment. Effect of chip production at sawmills on merchantibility standards for logs is discussed. Trends toward integrated logging operations are reviewed and new and specialized equipment developments are described. Extensive bibliography of logging literature is included.

THE LOGGING INDUSTRY throughout the United States and Canada remained in a healthy condition during 1956, with good demand and relatively high prices for saw and veneer logs, pulpwood, and the many other forest products produced. There was some slackening in demand for sawlogs, particularly for softwoods, during the latter part of the year as a result of the slowdown in home building. There were also increasing inroads into the market for round pulpwood from forest stands as a result of the tremendously increased volume of pulp chips made from slabs, edgings, and other mill residues.

Effects of Sawmill Chipping

Chip production at the sawmills, however, has reacted in another way on logging jobs. Throughout the United States and Canada, when sawmills install log debarkers and chippers and start to produce pulp chips, they soon relax their merchantability standards for acceptable logs.

According to the "Canadian Pulp and Paper Industry" for July, 1956:

"In sawmills where barkers and chippers have been installed . . . chip recovery was greater than anticipated. Recovery of less than half a unit of chips per thousand board feet of lumber produced is to be expected.

"Mills with barkers and chippers, however, recover up to .7 unit of chips per thousand board feet of lumber, because sale of chips permits a changed standard of utilization in the woods. Logs yielding small volumes of lumber and veneer can be processed economically where a plant can convert the balance of such logs to chips."

Many U. S. mills that have gone into the chipping business have just about thrown away previous log merchantability standards. Minimum log diameter has been reduced to as little as 6 inches, even on some West Coast operations, and the amount of rot, crookedness, and knottiness accepted is practically unlimited. On job after job, the specifications for a merchantable log now read "anything that will hold together during logging and transport."

One California operation tested the result of merchantability standards reduced in this way. It found in relogging a tract of pine and fir, logged the previous year to earlier standards, that it obtained 17 per cent more lumber volume, much of it of the highest grades, plus a material chip volume.

This practice has created many new problems for the logging operators. Not the least of these centers around the need for changes in methods of scaling and payment for woods work. One big West Coast operation has abandoned piecework rates for its loggers entirely and is paying them by the hour. Many operators in all parts of the country are now paying loggers according to gross instead of net scale. One operator in Virginia is paying his cutting, yarding, and hauling crews by the ton, rather than by the 1,000 board feet. Operators in West Virginia and New York State, logging tree lengths, are paying workers by the tree, regardless of size.

Integrated Logging

Integrated or multi-product logging has long been a theory expounded by foresters. Now the theory is being adopted in practice, not only on a few especially favorably situated operations, but generally over considerable sections of the country.

The theory, of course, is that all the usable volume of every tree cut should be removed from the forest, and then the portions of each tree that are best suited for different uses should be cut out and sent to the type of wood processing plant that can use each piece to the best advantage. In some cases these various types of plants are under the same ownership and management; in others they are independently owned, but cooperating in wood procurement.

The reasons why the practice of integrated logging has become so widespread, particularly in the hardwood stands in the East, are almost self-evident. Some of the most important of these are:

1. The growing scarcity and consequent high price of the higher grade products. Stands of hardwood suitable for high grade veneer, for example, are becoming difficult to find. There are, however, many sections of trees in lower grade stands entirely suitable for this type of use. As one pulp mill president said, "We simply cannot afford to put black cherry veneer logs, worth $450 a 1,000 board feet roadside, into our pulpwood chippers."

2. The development and widespread use of equipment and methods that make tree-length or full-tree logging more economical than bringing out only the "merchantable" sawlogs in log lengths on many operations. Among the devices used are the conventional crawler tractor, winch and arch combinations in adequate sizes; the newer four-wheel-drive, four-wheel-steer rubber tired skidding tractors with integral arches; mechanical loaders of various types capable of picking up products from large landing areas; and more adequate hauling equipment.

At the 1956 Northeastern Loggers' Congress several operators reported that logging costs were reduced 30 per cent on adequately equipped tree-length operations, as contrasted with the previous log-length jobs. Considerable additional material, suitable for sawtimber or other uses, was recovered on the tree-length jobs.

3. A beginning in the development and use of realistic log and wood grade specifications that make it possible for buckers to recognize and cut out portions of the tree stem best suited for different uses, such as veneer logs, sawlogs, turning bolts, pulpwood, charcoal wood, etc. Many industries have their own specifications, but

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Fig. 1.—Four-wheel drive, four-wheel-steer skidding tractor going up 50 per cent grade in the Klamath River logging country in northern California.

Fig. 2.—Small four-wheel-drive skidding tractor.

much work is being done in testing, correlating and standardizing these, by trade associations, colleges and universities, and research agencies.

Application of such grades is made easier by tree-length logging and bucking at the landing or on the mill deck. It is much easier to train and supervise a bucker to do the job correctly when the work is concentrated at such sites; and much easier for him to do the job when he is out in the open, away from rocks, brush, and other obstructions.

One Vermont hardwood veneer company reports that its yield of high grade veneer logs was increased 20 per cent when bucking was transferred to the landing. Hardwood lumber operators throughout the East have found that lumber value recovery is improved up to 20 per cent when the buckers are familiar with and apply the principles of the Forest Service's "Hardwood Log Grades for Standard Lumber." Much more research needs to be done in this grade specifications field.

Closer Utilization

Integrated logging and reduced merchantability specifications are resulting in closer utilization of the trees cut. New equipment is also resulting in closer utilization.

Throughout the country the general use of the gasoline-powered portable chain saw is resulting in the cutting of lower stumps and recovery of much valuable material formerly left in the woods. The chain saw is also making it economical to cut trees which are more crooked, or which have unusable sections due to rot, limbiness, or injury. This is because it is easier for the loggers to make their cuts in difficult places with the power saws, and because three or four cuts can be made in the time it formerly took to make one with the crosscut saw.

During 1956 chain saw manufacturers continued to improve their product. Practically all of them now make at least one model of a direct drive saw. There has also been a tendency to increase the cutting speeds of many reduction drive saws. These higher speeds, of course, are made possible by more wear-resistant alloys and better hardening methods for the shoulders of the cutting bars and the drive links on the chain.

The increasing use of rubber-tired skidding tractors is also resulting in closer utilization, because of their higher speeds as compared to crawler tractors, and ability to travel considerable distances with little or no road construction. Wheeled tractors are known to be skidding over distances as great as seven miles, travelling at rates of 12 miles an hour in rough country, both loaded and unloaded. On many jobs in the East they have made truck road construction in the woods completely unnecessary, and they have opened up considerable areas of back country to intensive forest management practices and made it possible to economically salvage much scattered merchantable timber in second-growth stands.

Fig. 3.—Wyssen cableway bringing tree length spruce, suspended completely off the ground, off steep mountain slope.

In the Northeast we now figure the sawmills are getting 1000 board feet of lumber from only 700 board feet of inventory volume, International 1/4-inch kerf log rule, removed from the forests.

Specialized Equipment Development

In addition to continuous improvement in equipment that is widely usable, such as the gasoline-powered chainsaw and the wheeled skidding tractor, much effort is being expended in the development and testing of equipment for specialized uses.

An example is new cable logging equipment suitable for use in managed timber stands in steep mountain terrain. It is estimated that one-third of the remaining uncut timberland in the northern Rockies is on this type of land, currently classified as inoperable because of steepness and watershed values.

The Wyssen Skyline Crane Co., Reichenbach, Switzerland, is attempting to demonstrate the feasibility of using the equipment they manufacture for logging this type of country, on the St. Joe River in northern Idaho and on another operation near Twisp, Wash.

In addition, the LeToureau Company, Longview, Texas, has installed a pilot model of a portable high-lead machine on the Payette National Forest in southern Idaho. The machine has a 74-foot tower and weighs 80 tons. The prototype is said to have cost $1 million to construct. The most unique feature is the all-electric drive of the winches, which can be electrically interlocked to permit tight-line skidding. Preliminary results in light selection cutting of ponderosa pine on steep slopes have proved surprisingly successful. Observers report an excellent skidding job, with a minimum

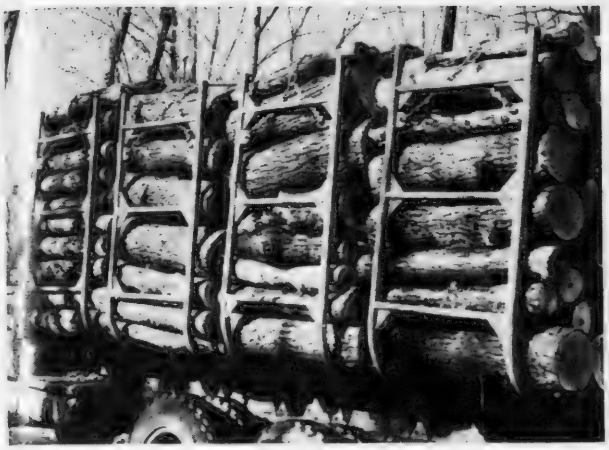

Fig. 4.—Tubular steel pallets for 4-foot hardwood pulpwood loaded on tandem axle truck.

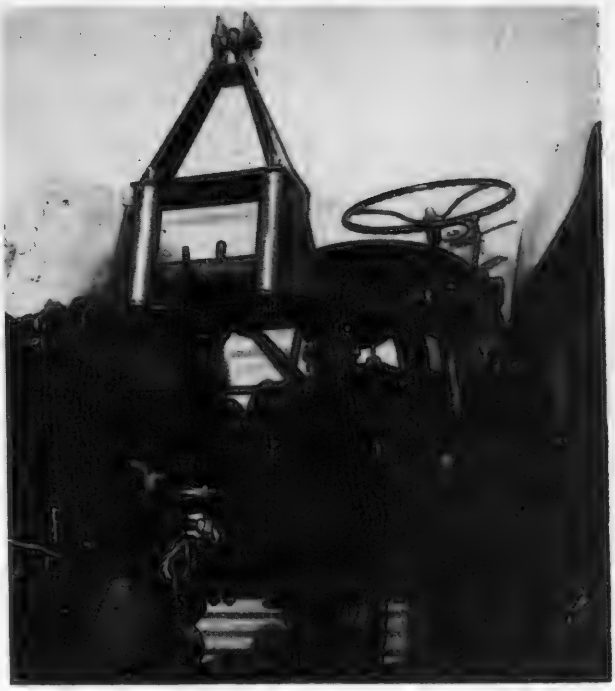

Fig. 5.—Skidding accessory for farm tractor, consisting of fairlead mounted on hydraulic lift drawbar and special logging winch.

amount of damage to soil and reserved trees.

The pallet system for handling pulpwood from the stump to the mill is another specialized type of equipment. It is reported that this system has continued to spread in the southern states, and that the use of semi-trailers carrying three or four pallets is growing. Much work is being done on improvement of methods of transportation of loaded pallets from the woods to the highway. Depending on ground conditions, three principal methods have been successful. They are: the tilting fork truck carrying a single pallet drawn by a truck, the tilting trailer carrying a single pallet drawn behind a tractor, and skidding pans carrying a pallet and drawn by a tractor.

In Canada the idea of fluming pulpwood and other products has been revived. Considerable success has been attained in such fluming through closed conduit systems, with a forced flow of water.

The small logging operator has not been neglected in this equipment development work. Many efficient intermittent use chain saws are now on the market, costing less than $200. These are constantly being improved.

During the year there were also placed on the market several special logging attachments for the ordinary farm tractor. The most unique of these is probably the one which provides a fairlead attachment for the hydraulic lift drawbar (with which most farm tractors are equipped), and a logging winch designed specifically to fit snugly to the back of the tractor inside the arms of the drawbar. The whole accessory is priced at less than $300.

Conclusion

During the year there were many regional meetings of loggers, including logging congresses, American Pulpwood Association Technical Committee meetings, and sessions at the meetings of regional lumber trade associations, at which these and other developments were discussed in detail. The proceedings of some of these meetings are listed in the Bibliography which follows.

All of these developments, of course, are aimed toward assuring a continued supply of wood raw materials to the forest products industries of the type they need, and at a price they can afford to pay. That loggers, together with the equipment manufacturers and the research agencies, have succeeded in accomplishing these goals as well as they have in the face of rapidly increasing costs for labor, equipment, and supplies, and poorer and more inaccessible timber stands, is a tribute to their ingenuity and resourcefulness.

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Developments in Milling—1956

MILTON H. MATER

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Discusses trends in lumber production throughout the U. S., increase in medium-sized mills, developments in milling equipment and methods, and increased mechanization and automation. Utilization of wood residues is reported increasing in all regions. Current research studies in sawmilling are described and meetings are reported which covered topics of interest to the lumber manufacturing industry.

REPORTS ON DEVELOPMENTS IN MILLING during 1956 from the 14 regional chairmen who comprise the Lumber Manufacturing Division strongly emphasize the sharp regional differences in the lumber industry, differences in the general conditions, milling technology, research and development, and other aspects of milling. This year's reports also bring out the "fluidity" of the lumber industry in both the United States and Canada —mergers, mills opening, closing, modernizing, and the increasing criss-crossing of techniques from region to region.

The Lumber Manufacturing Division, organized at the annual meeting in Asheville in June 1956 from the former milling subcommittee of the Logging and Milling Committee, is divided into 14 natural regions.[1] These are: Northeastern U. S. Softwood, Northeastern U. S. Hardwood, Lake States, Eastern Canadian Softwood, Eastern Canadian Hardwood, Appalachian, Southeastern U. S. Softwood, Central, Southwest Pine, California Pine, Redwood, Northwest Douglas-fir, Northwest Hardwood, and Canadian Douglas-fir. This Annual Review is a compilation of written surveys by regional chairmen.

[1] See Fig. 1 for regional boundaries.

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Production Decreases in Most Regions

The Canadian Douglas-fir region production (Region 11) appears to have dropped about 9 per cent below 1955 production, while in Northwestern (10a) mills production was at the lowest point in the past five-year period, except for the strike-torn year of 1954.

Northwest mill men will remember 1956 as the year that started off with a boom and ended with the lowest lumber prices in two years and more mills shut down "indefinitely" than in any comparable period in two years. 1956 was also the year of the big merger in the Northwest. Georgia Pacific's acquisition of Coos Bay Lumber Co. and other assets of the Dant & Russell Empire and Hammond Lumber Co.; the Simpson Timber Co. purchase of M & M Woodworking and California Mills; and Long-Bell's merger with International Paper Co. were headline makers, while innumerable smaller mills merged with less fanfare.

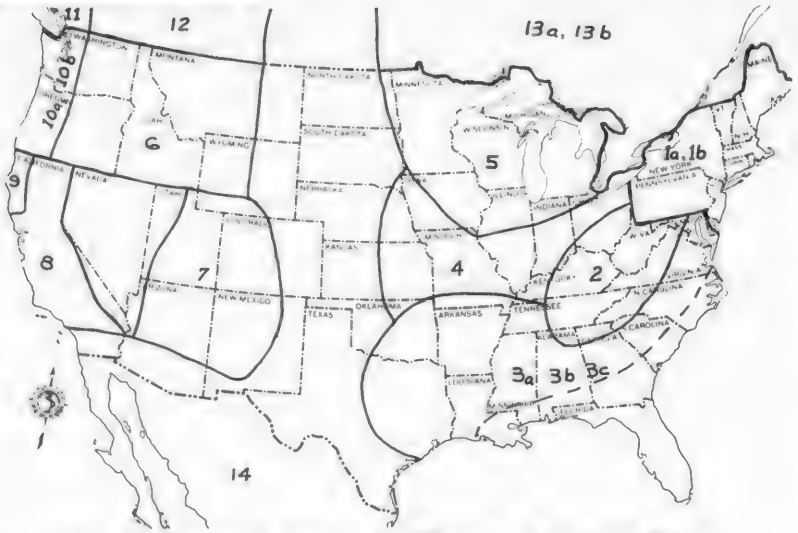

Fig. 1.—Geographical regions of the FPRS Lumber Manufacturing Division.

Production was also about 5 per cent lower than 1955 in the Central Region (4), Inland Empire, the Lake States (5), Eastern Canadian Softwood (except for the Province of Quebec, which showed a slight increase) (13A); about the same in Appalachian (2), Redwood (8), and Southeastern Regions (3). Only the Northeastern Hardwood (10b) and Southwest Pine Regions (7) report a good year, with production on the increase.

The "tight money" situation, with the curtailment of mortgage money resulting in a decrease in new home starts and decreased markets for lumber, was named as the prime cause for the decreased production, although in several regions bad weather and strikes contributed to sawmill difficulties.

Medium Sized Mills Gain

Fewer than 20 new mills in all regions combined were reported for 1956; most of these are the larger, more spectacular mills. In the regions which cut mostly logs of smaller diameter, such as the Southeastern, Lake States, Northeast, Southwest Pine, Eastern Canadian Softwood, and Appalachian, small mills appear to be giving way to medium sized mills, while large mills are tending to decrease in number. In the Lake States, only eight mills cutting over 10 million bd. ft. per year are still in operation. Most of the 5,000 mills in the region are still small part-time operations which produce, however, a large proportion of the regional total.

The Canadian Douglas-fir and redwood regions (9) report little change in mill size, but in the Northwestern U. S. a few more old-time mills passed out of the picture because of over-sized equipment for the small logs that were available.

The Northwest Hardwood Region—a relative newcomer to the lumber industry—has seen many small mills discontinue operation this past year. But a major portion of Northwestern hardwood production has been taken over by larger mills. Georgia-Pacific, Weyerhaeuser, and more recently Diamond Match Co. in Chico, Calif. have begun to produce hardwood. The appearance of these large and many medium sized mills in the hardwood picture means greater utilization with resulting increase in quality.

Gangs, Band Mills, Resaws, Barkers Find Increased Use

While the ratio of band to circular mills remained about the same in the Northwestern Douglas-fir Region, the young Western Hardwood Region saw a trend toward bandmills in 1956. The Central Region still has 95 per cent circular rigs, as has the Northeastern Region, but in the Eastern Canadian Softwood and parts of the Southeast the number of bandmills is increasing. Almost all large producers in the Southwestern Pine Region are now bandmills and the trend toward bandmills is increasing in the Redwood Region. The bandmill is gradually replacing circular saws in the California Pine Region.

The gang mill appears to be coming into increased favor with operators in the Central, Redwood, Southeastern Southwest Pine, and Eastern Canadian Softwood Regions. Gangs in Northeastern hardwood mills are installed in only a few specialty mills and then only as a supplementary rig to the standard circular or bandrig. A number of gangs were installed during the year in Southeastern mills and in small mills in Colorado and New Mexico to increase production. The sawing procedure is generally canting on a conventional headrig and then sending the cants through the gang.

Interest in barkers was high in the Lake States and in the Appalachian Region but none were reported installed. However, in the Canadian Douglas-fir region six mechanical and one hydraulic barker were installed during 1956. In the Southeast more and more debarkers are being installed, even in mills cutting only 30,000 bd. ft. per day. The Cambio debarker is proving popular with mill operators in this region, and in the Eastern Canadian Softwood Region, where several were installed during the year. The Northeast has seen a great increase in interest in debarkers, at the expense of log ponds.

There is little interest in debarkers in the Southwest Pine Region at present and while no hydraulic barkers are being installed at present in the Redwood Region, one redwood mill has installed a peeling deck to ease handling logs for hand barking operation. An air powered hand barking tool is being tried at one redwood mill. Log barkers are being installed in the California Pine Region to maximize yield. One California pine mill reported a production increase of 50 per cent with the installation of a cant gang saw, used in conjunction with a circular headrig.

Increased utilization of lumber is forecast in the increased number of resaws being placed in mills. Two new mills in the Lake States are being equipped with horizontal resaws. In the Central States the larger mills have resaws, but none of them are horizontal. In recent months, two operations in the Southwestern Pine Region have put in line-bar resaws behind the headrigs for further log breakdown. Redwood mills are installing more resaws, both horizontal and vertical bands. Blow hogs are also replacing the old style hogging equipment.

A number of Canadian Douglas-fir mills have installed linebars, operated by air cylinders. One uses an electronic hydraulic setworks with 10 preset buttons. Resaws and similar equipment are a rarity in most small log regions except for the very large mills.

Increased Mechanization and Automation Fan Sawmill Interest

Mechanization and the potentialities of the application of automation principles to sawmill operation continue to be major topics of conversation in the industry. Though a fully automated log haul and log deck was put in operation in a California redwood mill last year, few developments in sawmill automation are actually in use

The automatic "riderless" carriage, introduced 10 years ago, is steadily becoming standard sawmill equipment. An automatic carriage was installed in one of the largest California pine mills in 1956, generating much interest over the role of the automatic setworks in that area. Opinions are as diverse and varied as there are sawmill men expressing themselves on the subject, but it is reported that the majority seem to favor the automatic carriage.

The Western-developed automatic carriages have crossed regional boundaries and this year were successfully installed in a number of Southeastern and Northeastern mills. Many Southwestern pine mills have had automatic carriages since they were first developed and few new installations are the setter type. New automatic carriage installations in large Canadian Douglas-fir mills have also aroused considerable interest.

Although a number of mills in the Inland Empire have been using automatic carriages for some years, last year several such carriages were installed in very large, fast pine mills in the area. A preliminary study by the Western Pine Association showed an increase in both production and productivity with the installation of such carriages. The definite trend to automatic carriages has led several manufacturers of conventional type headrigs to produce various types of sawyer operated setworks.

Lutcher & Moore Lumber Co., Orange, Texas, is building one of the most completely automatic mills in the U.S.A., using such new equipment as TV sets to handle lumber around the kilns. Modernization of Oval Wood Dish Corp., Tupper Lake, N. Y., was completed at year's end and is attracting considerable interest in the area for its increased production with sharply decreased manpower. Interest in mill redesign to eliminate as much labor as possible without affecting or reducing production was reported in most areas. This interest is particularly high in those areas which had relatively inexpensive labor prior to the $1.00 minimum wage law which went into effect in March 1956.

Completely mechanized log decks and log carriages have been fully developed and have thus far aroused most interest. However, mechanization is moving onto the sawmill edger and other equipment. In the Canadian Douglas-fir Region, a number of mills have already installed hydraulically operated setworks on the edgers. In a couple of mills, automatic devices have been installed behind the edgers to separate the edgings from lumber, eliminating the tail edger. An electric shift edger introduced in the Southeast is still in the development stage.

Fig. 2.—Fully automated log deck in a redwood mill. Logs are bucked in the pond and log movement to the log stop and loader is controlled photoelectrically. The sawyer loads the logs on the carriage and handles the turning by pushing buttons. There are no men on the deck.

One mill in the Lake States has electrically controlled transfer skids that automatically send the boards on either side of the edger to the edgerman. He transfers the lumber at 90 degree angles from the live rolls coming from the headrig to chains going over the edgers.

In the Central, Appalachian, and Northeastern states, few mills have edgers. Many mills in the Central Region still edge their lumber on the headrig with resulting waste, as they edge to the narrowest board. Many mills in the Northeastern Hardwood Region are putting in edgers, although most are used and often too worn for accurate edging. Use of the shadowline for more accurate edging is increasing.

Wood Residue Utilization Slated To Increase

Increasing production of wood chips for pulp is news from the Northwest hardwood and softwood mills. Conversion to chip recovery has actually created a shortage of domestic fire wood in many areas. The shortage of domestic fuel has improved the overall utilization of small mill residues considerably in rural and suburban areas. Fuel dealers in larger cities are trucking appreciable volumes of mill residues into urban areas for fireplace use. Metropolitan mills are interested only in chips.

In the Southeast the use of chips for paper mills is at a new high. There is some talk about using sawdust to manufacture paper.

Northeastern hardwood mills are showing a marked interest in slab and edge chipping for paper pulp. Some large paper mills are looking forward to receiving an increasing percentage of their raw material from this type of wood residue. The Eastern Canadian softwood mills have found the place of pulp chips from slabs and edgings firmly established in the pulp industry. It is estimated that over 100,000 cords of chips were obtained from sawmill residues last year in that area. In the Lake States there is an active interest by pulp mills in developing a source of clean hardwood chips and by sawmills to obtain suitable log debarkers and slab chippers to meet these demands.

In Illinois both roofing plants and paper mills use wood chips. A mill in Iowa has been investigating Missouri's timber for use as pulp. Investigation has resulted in the opinion that a pulpmill is not yet due in Missouri, but will be within a few years.

The home barbecue trend has opened up increasing markets for charcoal in the Central, Appalachian, and other Eastern regions. A new plant was opened up in Burnside, Kentucky, to produce charcoal and furfural.

Chips for fiberboard have increased in the Redwood Region. Fiberboard Products Inc., Antioch, Calif., is now obtaining 75 percent of its total raw material from waste wood, largely from the California Pine Region. This represents a considerable increase over the 30 per cent provided from waste wood six years ago. This company is also now utilizing eucalyptis chips in the production of Asplund semi-chemical pulp. Interest in particle board plants is high in most regions, but little actual activity is reported.

In British Columbia, the Rayflow plant to produce drilling muds from hemlock bark started operation.

Research Projects Pace New Developments

Research projects during the year include the expansion of research facilities in many areas, special project reports, and utilization experiments. The recently activated Northwest Hardwood Association was completing its report on the management of hardwood lands and timber. The Ford Forestry Center of Michigan College of Mining and Technology near L'Anse, Mich. has converted from steam to electricity to increase its experimental capacity. A novel bark peeling machine invented by the staff of the Forest Products Research Division, Michigan Tech., is now in the hands of the Prescott Co., Menominee, Wis.

The University of Missouri has completed a mill scale study of the economics of graded lumber vs. mill run and plans a bulletin on the results.

Two new Forest Products Laboratories are under construction in Vancouver, B. C. and Ottawa and a new Oregon Forest Products Laboratory is scheduled for 1957. The Forest Products Laboratory at Berkeley, Calif., completed in 1955, has had much of its new equipment installed and is now staffed. Research projects by the Ottawa Laboratory covered short log bolters, fundamental research on sawing, and the economics of pulp chip production.

A research project sponsored by the Hammond Lumber Co., Samoa, Calif., laid the groundwork for completely automatic sawing. Research facilities at North Carolina State College are also expanded.

A number of new company research laboratories were established, mostly devoted to increased wood utilization. The new laboratories include the Olin Mathieson Chemical Corp., Monroe, La., and the Poinsett Lumber and Manufacturing Co. (Division of Singer Sewing Machine Co.), Pickens, S. C. Southwest Lumber Mills, Inc., McNary, Ariz., and Potlatch Forests, Inc., Lewiston, Idaho, have also expanded their research facilities.

Meetings and Conferences Discuss Sawmill Problems

Most regions reported a number of meetings and conferences of interest to sawmills. As previously, most meetings of direct interest to sawmill operators were held in the Central and Eastern Regions. In the West, sawmill superintendents and managers discussed technical questions at meetings of regional sawmill clubs or species associations.

A joint meeting of the FPRS Inland Empire and Pacific Northwest Sections, the first of its kind, attracted a large attendance. A special session of sawmill interest was devoted largely to the question of arriving at inter-regional agreement on sawmill definitions.

The Lumber Manufacturing Division, in conjunction with a special ASME Committee, devoted considerable effort to sawmill terminology during the year, correlating the opinions of experts in all regions. Norman C. Bye, Henry Disston Co. began the task of compiling a list of research projects in sawmilling which members of the Lumber Manufacturing Division feel should be undertaken. This was one of the projects undertaken by the Lumber Manufacturing Division at the annual meeting in Ashville, N. C.

Members of the Lumber Manufacturing Division contributing to this report were: D. P. Thomas, Paul Heller, Siegfried Tolle, R. A. Blaser, John P. Sims, John B. Veach, Jr., Richard W. Connor, G. E. Bell, Jack R. Pfeiffer, Tom Shelton, Pete Johnson, W. J. O'Neil.

Finishing Developments—1956[1]

F. H. THOMAS

Chairman, FPRS Wood Finishing Division

Discusses research and development in paints and finishes during the past year. Covers developments in house paints, natural exterior and natural interior finishes, furniture color, wood, and finish trends. Finish application systems are discussed and efforts to upgrade furniture finishes are reported.

THE SALE AND USE of exterior flat house paints of the conventional or "solution" type have expanded during the past year. They are often recommended for both wood and masonry surfaces, new or repaint, with specific recommendations for first or priming coats on each type of surface.

The use of exterior emulsion paints on masonry surfaces has increased, and testing of exterior emulsion paints on wood surfaces, new or repaint, is becoming quite general. Flat exterior paints show to best advantage on textured surfaces—on wood, such as on rough sawn siding, shingles, raked shakes, etc., and on masonry, as on brick, stucco, cement-asbestos shingles, etc.

More attention is being paid to the brushing qualities of all exterior paints. In gloss house paints, blister and stain resistance is claimed for certain paints, their blister resistance usually predicated on their use on bare wood. Their formulations are based on non-reactive pigmentations, with the elimination of zinc oxide increasing the problems of controlling attack by fungi. Vehicles for trim paints and dark-colored house paints are continuing their previous move in the direction of full alkyds, and the use of color continues to expand.

Papers on blister- and stain-resistant paints will be presented at the FPRS' 11th National Meeting in Buffalo.

New developments of interior paints have been principally velvet sheen enamels and paints of low and unobjectionable odor (odorless paints).

Natural Exterior Wood Finishes

Due to the popularity of ranch style homes, many wood associations, private research organizations, and the U. S. Forest Products Laboratory, as well as private industry, have studied the best methods of finishing wood siding to preserve the natural beauty of the wood.

The necessity for frequent renewal of exterior clear finishes for wood has contributed to greater popularity of semi-transparent pigmented stains which are more durable and present much less of a problem if a subsequent

[1] Contributing to this report were: M. VanLoo, R. S. Taub, D. F. Laughnan, W. E. Pratt, G. A. Lenaeus, and D. G. Lubeck. Other members of the committee are: R. M. Carter, P. F. DeSaix, C. Reckers, T. H. Moran, T. E. Werkema, C. A. Rasmussen, F. L. Browne, A. J. Wandersleben, and R. B. Shurts.

The Author: F. H. Thomas is Director, Furniture Technical Service Dept. Sherwin-Williams Co., Chicago, Ill.

decision is made to change to fully pigmented paints. Exterior pigmented emulsion stains have appeared on the market.

Several publications have been offered in 1956. Among these are:

1. California Redwood Assn. Exterior Finishes for Redwood.
2. Forest Products Laboratory, Natural Finish. News Release, August 17, 1956.
3. U. S. Dept. of Agriculture. Home and Garden Bulletin 52, Wood Siding, How to Install It, Paint It, Care for It.

We refer you also to the 1954 Preprint of the Forest Products Research Society, Natural Wood Finishes for Exteriors of Homes, by Don F. Laughnan, a paper given at the FPRS' 8th National Meeting in Grand Rapids, Mich.

Natural Interior Wood Finishes for Wood Paneling

The popularity of wood interiors for dens, recreation rooms, enclosed porches, house trailers, prefabricated houses, etc., has brought on the market a whole line of stains, varnishes, and lacquers both for spray and brush application that will enhance and preserve the natural beauty of the many woods being used Some of these woods are birch, pine, wattled walnut, and various Philippine mahoganies. Some of the plywood is prefinished at the factory and shipped ready to install.

Furniture

The color trend in furniture was to medium range—many warm browns—away from very light or very dark; and clear tones—away from highly pigmented finishes.

Walnut and cherry woods grew in popularity to a great extent, at the expense of oak and mahogany.

Finishes: Plastic finishes claimed a substantial part of the market for flat surfaces such as table tops, dresser tops, and school desk tops, where there was a demand for maximum toughness, adhesion, mar resistance, and resistance to water, alcohol, and burning cigarettes.

The inroads of plastics was being met with the Beautyguard process by the manufacturers of high grade wood furniture. This process couples a high grade synthetic finish with a plywood construction in which a thin sheet of aluminum foil is placed directly under the face veneer to conduct heat away from the finish. This combination gives a surface that is more resistant to heat and other abuse than conventional finishes. Some 15 furniture manufacturers adopted this process in 1956.

Cabinets principally television, continued to be predominately masonite with a printed wood grain finish.

Research work was being done on the following:

1. Impregnation of wood to improve moisture resistance, dimensional stability, and hardness.
2. Use of ultra violet absorbers to prevent color change of wood upon exposure to sunlight.
3. More resistant finishes. Among these the catalyzed ether resin and polyester type finishes looked the most promising. Problems were adhesion to undercoats and short pot life, introducing necessity of dual spray gun.

Application

Hot spraying of lacquers (140°–160° F.) grew slowly, with greater interest deevloping in the use of warm spray (100°–125° F.) for positive year-round control.

There was at least one installation of steam spray and one of airless atomization for finishing furniture or cabinets. It is expected that these processes, like hot spray, will find specific application in the furniture field rather slowly.

Upgrading of Finishes

There was considerable effort undertaken to upgrade furniture finishes by both the finishes industry and the furniture manufacturers. A joint industries committee of representatives of the furniture manufacturers' association and the National Paint Varnish and Lacquer Assn. was formed.

One of the first undertakings of this committee was a panel discussion on "Color Control in Furniture Finishing" held during the N.A.F.M. Fair in Chicago and repeated in Los Angeles at the convention of the Furniture Manufacturers Assn. of Southern California. The factors discussed were: Wood Selection and Preparation, Finishing Materials Selection and Testing, Application of Finish, and Inspection as a Factor in Color Control.

Another project that this committee is undertaking is the revision and simplification of the National P. V. & L. Assn's. booklet on Control Testing Methods for Wood Finishes. Some of the methods of test were demonstrated at both the Chicago and Los Angeles conventions.

A paper on Color Control in Furniture Finishing will be presented at the FPRS' 11th National Meeting in Buffalo in June.

Activities in the Field of Wood Products Preservation in the United States in 1955-56

IRA HATFIELD

Chairman, FPRS Wood Preservation Division

Summarizes advances in wood products preservation field during the past year. Discusses new research on preservatives, research and technical activities, new specifications for preservatives and their application, advances in methodology, association activities, and general items of interest. Extensive literature citations are given, chiefly for 1955 and to June 1956.

IN OUR COMMITTEE REPORT to the Society at last year's annual convention, we poitned out the difficulty of covering just those items that matured or progressed during a given period of time, and also stated that one is apt to miss some items in such a compilation. The Committee this year was composed of members from all regions of the United States in an attempt to get as complete coverage as possible. If there are omissions of information or literature citations, such omissions were unintentional, and can be reduced in future years if all interested parties will send pertinent information to the Chairman regardless of whether those sending in such information are members of the Committee.

Despite the fine cooperation and technical advances of foreign scientists, our Committee membership was inadequate to cover foreign activities or publications in a way that would do justice to such work. It is with regret that we have not been able to report this year on foreign activities in the field covered by this Committee. Although the references to foreign literature are incomplete and their accuracy has not been checked, the citations sent to the Chairman of the Committee have been included in this year's report.

The Society outlined certain functions to be carried out by the Wood Products Preservation Committee. This year's report will be divided into seven headings covering those specific functions.

The Author: Ira Hatfield holds A. B. from Simpson College, M. S. from Colorado Agricultural College, took advanced work at U. of Wisconsin. He was employed by U.S.D.A. Bureau of Plant Industry from 1929–36, plant pathologist with Monsanto Chemical Co. 1936–46, co-owner of Planetary Chemical Co. 1946–49, Manager, Industrial Preservatives Section, Monsanto Chemical Co., 1949–56, is now Director of Research, Wood Treating Chemicals Co., St. Louis, Mo.

I. New Research on Wood and Wood Products Preservatives

The only entirely new chemical we have had called to our attention in the field of wood preservatives is the work by Smith, Bottoms, *et al.* (85)[1] as described at one of the technical sessions of the 1956 FPRS annual convention. The process and chemicals used are reported to permanently bind copper to wood cellulose without appreciably modifying the properties (except that of fungus resistance) of the cellulose.

Another product which has been known to have fungicidal properties, but which has not been used extensively in wood preservation, has received increased attention for applications where lack of odor, low toxicity to plants and animals, and suitability on food containers are important. We refer to formulations of copper 8-quinolinolate. Two articles describing its use around food products will be of special interest. One by Richardson and Ogilvy (79) reported on studies pertinent to problems around a meat packing plant; the other by Goldfarb (41) dealt with applications on wooden containers and pallets.

II. New Research and Technical Activity Contributing Directly to Knowledge of the Better Utilization of Cellulose Preservative or Processes

New Research: Based on a patent to Davis (34) covering "a semi-stable, highly viscous, self-sustaining oil-in-water emulsion" and a method of treating wood with it, Wood Treating Chemicals Co. undertook the development of such a product for the treatment of standing poles at the ground line, of field cuts and holes in freshly treated timbers and piling, and for application to wood items in existing structures. A paper on this application was given by Van Allen (92) at a technical session of the 1956 FPRS annual convention.

Another phase of research that possibly fits into this part of our report rather than under Methodology has to do with the development of a field method for showing the depth of penetration of colorless oil-borne preservatives solutions in treated wood. Where procuring agencies had suggested the use of color additives to such oil solutions, treating plants often encountered increased sludging problems, and had the scope of usefulness of their treating solutions limited because wood treated with colored solutions could not be used where finishing coats were to be applied or where natural color of the wood was a requisite.

Research on a suitable solution to this inspection problem has taken two directions, both centering upon the use of fluorescence with black light. One approach has been to find petroleum oils that naturally fluoresce, the other is to develop dye indicators that can be applied to increment borings taken from treated wood.[2]

A third research project in wood preservation that matured this year was that sponsored by the American Wood Preservers Institute at the U. S. Forest Products Laboratory. This work is summarized in a report by Blew (19). It covered a comparative study of the results of pressure and non-pressure treatment of end-matched Douglas-fir and shortleaf pine lumber.

Technical Activities: Several associations have had committees active on projects that were directly concerned with wood preservation. It would be impractical in this report to try to list all such activities of the American Wood–Preservers' Association, American Railway Engineering Association, American Society of Testing Materials, and others. For reports on such activities, the readers are referred to the annual proceedings and technical journals of those organizations.

Although we will comment later about activities of the F.H.A. and the

[1] Numbers in parenthesis refer to literature citations.

[2] Since the presentation of this report in June the use of a fluorescent dye indicator has become quite prevalent at plants as an inspection method.

B.R.A.B. committee working with it, we will mention here that the American Wood Preservers Institute (AWPI) prepared a report on the availability of pressure-treated lumber in the United States. This 60-page report (7) traced lumber from the mill through treating plants and on to the consumer. It listed over 200 pressure-treating plants by states, location, company names, and types of treating done at the plants. A section of the report was devoted to a pictorial presentation of stocks on hand and data on quantities sold.

Another activity of the AWPI was the initiation of a service test on creosote and 70/30 creosote coal-tar to compare their value for marine organisms control. Douglas-fir piling treated with these products were installed in the Los Angeles harbor. The Los Angeles Harbor Department, by the way, is actively engaged in studying and collecting service records on marine organisms' control, and this cooperative work is therefore much in order.

American Railway Engineering Association, through its Committee 17 on Wood Preservation, is carrying forward its plan to establish a termite test plot in cooperation with the University of Florida. An appropriation has been approved by the AREA Board for the project to study the termite resistance of wood treated with several wood preservatives.

Reference should be made here to the procurement activities of various military agencies in the matter of water repellent preservatives for lumber and dimension materials. Lacking an AWPA standard for such treatment and lacking a Federal specification for other than individual items that would be involved in the procurement of wood pressure-treated with water repellent preservatives, the Corps of Engineers and others have developed their own specifications and have already procured millions of feet of lumber thus treated.

As an example of this activity, the South Atlantic Division of the Corps of Engineers has specified the chemical treatment of soil for termite control and pressure treatment of sills and lumber in contact with masonry in six housing projects totaling 3,758 houses. This Corps of Engineers work points out that groups outside wood preservation organizations are having to supply specifications for work without the benefit of standard specifications.

We were not able to obtain comprehensive listing of wood preservation projects now under way at various institutions and private laboratories. Chapman Chemical Co. reports it has completed a study of the effects of final steaming on the gradient of pentachlorophenol in pressure-treated wood and expects to offer the manuscript for publication soon. It also reports another completed work on the correlation of penta gradient with length of pressure period.

—Photo courtesy American Forest Products Industries

Fig. 1.—Posts entering pressure-treatment cylinder.

The Oregon Forest Products Laboratory reports active projects on:

a) The pressure treatment of tanoak lumber with water-borne preservatives.

b) The preservative treatment of eight Oregon conifers by the full-cell, Lowry, and Rueping processes.

c) Preliminary investigation of the seasoning and treatment of red alder, Oregon maple, and Oregon white oak.

d) Evaluation of preservative treatments: non-pressure-treated green Douglas-fir poles, butt-treated split cedar posts, treated greenhouse seed flats and benches, corrosion of staples in double diffusion-treated wood, corrosion of metal fastenings in treated and untreated wood.

e) Service life of treated and untreated fence posts.

f) The kiln drying of Douglas-fir treated with water-borne preservatives.

The State College of Washington (Pullman) Dept. of Botany is studying the control of decay in decked pulpwood by water spray. The Forest Insect Laboratory, Southern Forest Experiment Station, Gulfport, Miss., is conducting research on the protection of stored pulpwood from insect attack by application of insecticides. The University of Washington, Seattle is initiating a stake test program for evaluating wood preservatives and is also investigating the physiology of *Limnoria*.

The California Forest Products Laboratory, Richmond, has a project in cooperation with the U. S. Forest Products Laboratory to determine the nature of the extractive components which act as natural fungicides in decay resistant woods, such as redwood, incense, and Port Orford cedars. Some 20 different extractives have been isolated and are undergoing bioassays against various wood destroying fungi.

The New York State College of Agriculture, Ithaca, established a series of five test plots in 1955 to study the effectiveness of Osmose products on common northern hardwoods. They are also initiating double-diffusion tests using copper sulfate and sodium hydroxide.

The Plywood Manufacturers of British Columbia, Technical Advisory Committee on Treated Plywood, report projects on:

a) Survey of existing data on the preservative treatment of plywood.

b) Exposure ratings for plywood and recommended preservative treatments.

The University of British Columbia, Vancouver, Faculty of Forestry, report they are conducting a study on fungicidal toxicity of certain extraneous components in Douglas-fir heartwood.

George M. Hunt, former director of the U. S. Forest Products Laboratory, reports that the Forest Products Laboratory, College, Laguna, Philippines, is getting underway with help from the International Cooperation Administration and the U. N. Food and Agricultural Organization. Books and periodicals are one of the needs of this new laboratory. Perhaps members of FPRS have copies that they would like to give to this group.

III. New Specifications for Preservatives and for Application of Preservatives to Wood and Wood Products

It is recognized that the following list is incomplete. An attempt has been made to bring it as up to date as possible for this report.

American Wood-Preservers' Association (R—Revision, N—New, T—Tentative):

P4–55 Standard for Petroleum for Blending with Creosote (R).

P5–55 Standards for Water-Borne Preservatives (R).

C1–55 Standard for Preservative Treatment by Pressure Processes—All Timber Products (R).

C4–55 Standard for the Preservative Treatment of Poles by Pressure Processes (R).

C5–55 Standard for the Preservative Treatment of Posts by Pressure Processes (R).

C11–55 Standard for the Preservative Treatment of Wood Blocks for Floors and Platforms by Pressure Processes (R).

C20–55 Standard for Pressure Treatment of Fire Retardant Structural Lumber (R).

A1–55 Standard Methods for Analysis of Creosote (R).

A2–55 Standard Methods for Analysis of Water-Borne Preservatives and Fire-Retardant Formulations (R).

A3–55 Standard Methods for Determining Penetration of Preservatives (R).

M6–55 Brands Used on Forest Products (R).

M7–55 Standard Method for Field Tests With Stakes (N).

Reports from various AWPA Committees brought in recommendations that certain Tentaitve Specifications be elevated to Standard, but such action is dependent upon confirmation by letter ballot, so such specifications cannot be accurately added to the list at this time (June 1956).

American Society of Testing Materials Committee D-7 on Wood: It was recommended that the following three tentative Standards be elevated to full Standards (voting to take place at 1956 annual convention).

D 1271–53T Copperized Chromated Zinc Chloride.

D 1272–53T Pentachlorophenol.

D 1325–54T Ammoniacal Copper Arsenite.

A proposed Tentative Method for Testing Wood Preservatives by Laboratory Soil-Block Cultures was referred to Committee D–7.

Department of the Army, Corps of Engineers, Office of the Chief of Engineers: CE–235 September 1955 Guide Specification for Military Construction — Carpentry (for Building Construction).

This is a useful specification covering materials used in construction. Attention is specially called to section 07 on treated lumber, which calls for certain items to be pressure treated. This is a marked step forward in the subject of protection of wood in buildings.

Federal Specifications: In the revision of TT–W–571, Specification TT–W–572 is now being included as an applicable specification, thus extending the use of water-repellent materials.

Rural Electrification Administration: In 1955 the REA circulated a preliminary draft of "Specifications for poles, reinforcing stubs and anchor logs and for preservative treatment of these materials to be purchased by REA borrowers". It was to supersede REA Bulletin 345–1 (telephone specification) and DT–5 (electrical specification). This has not yet been issued as a complete specification.

IV. Advances in Methodology

During the year 1955–56, the activities of a group of interested companies and agencies, cooperating with the U. S. Forest Products Laboratory, completed five years of intensive study on the standardization of a laboratory method for evaluating wood preservatives. It is of value to call this to the attention of the FPRS, for it illustrates what can be done economically when interests are pooled and research efforts are coordinated. The method has been proposed as a Tentative ASTM method.

Several papers have matured dealing with this cooperative work, and citations to them can be found in the bibliography of the paper presented before the AWPA by Duncan (36) in 1955. Seldom does one have an idea of the cost of the development of such a standard, but in this case it is estimated that well over $50,000 went into the research costs.

As an outgrowth of this study and as parallel work has gone on in different laboratories, other papers have matured describing certain phases of such research. One such study dealt with comparing oven-dried and conditioned blocks and the use of vented incubation bottles. This work was described by Snoke (87). Another study has centered around the perfection of a method of leaching the specimens to try to correlate that phase of the testing with actual service data. A valuable paper on this subject with a comprehensive review of the literature was presented by Baechler[3] at the April 1956 AWPA convention. A listing of 52 literature citations in Baechler's paper will make it a valuable source paper for research workers in this field.

We have already mentioned the AWPA standard for field tests with stakes, and the research on methods of determining the penetration of colorless oil-borne preservatives in treated wood.

A fairly new technique being employed to study the distribution of preservatives in wood makes use of radioisotopes. For the benefit of those who wish to familiarize themselves with this subject, their attention is called to the book by Comar (30), to the section on radioactivity of Encyclopedia Brittanica, and to the article that appeared in the June 1950 issue of Bell Laboratory Record (17). Comar's book lists over 600 references, and the following quotation from his book may be interesting: "Radioisotope techniques, to the naive, may represent the panacea for investigational difficulties—the royal road to successful experimentation; to the cynic they appear as a gadgetry, a fad that creates more problems than it solves. As always, the truth lies somewhere between the extremes."

Although the following comments are not directly concerned with wood preservation, the information has a direct bearing on the subject of radioisotopes, of analytical methods, and with one of the wood preservatives—pentachlorophenol. In order to study the possible translocation of penta in cotton plants on which penta formulations had been sprayed to effect desiccation, isotope techniques involving the labeling of penta with C–14 in the 1 position were used. By using this technique it was possible for Jaworski (51) to show that less than 0.01 ppm. of penta would be present in expressed cottonseed oil from sprayed cotton plants.

It should be pointed out that radioactive techniques are expensive. For example, at one time the estimated cost of one microcurie of custom-built radioactive pentachlorophenol was $2,000. The commercial charge for counting (analyzing) test samples of treated wood has been about $25 each. These radioactive compounds are often dangerous to use if not properly handled, and their use requires some background development in nuclear physics. Although they may not be useful for small-scale tests, radioisotopes offer one of the most promising

[3] Baechler, R. H. 1956. Laboratory leaching and decay tests on pine and oak blocks treated with several preservative salts. Presented at the April 1956 meeting of AWPA.

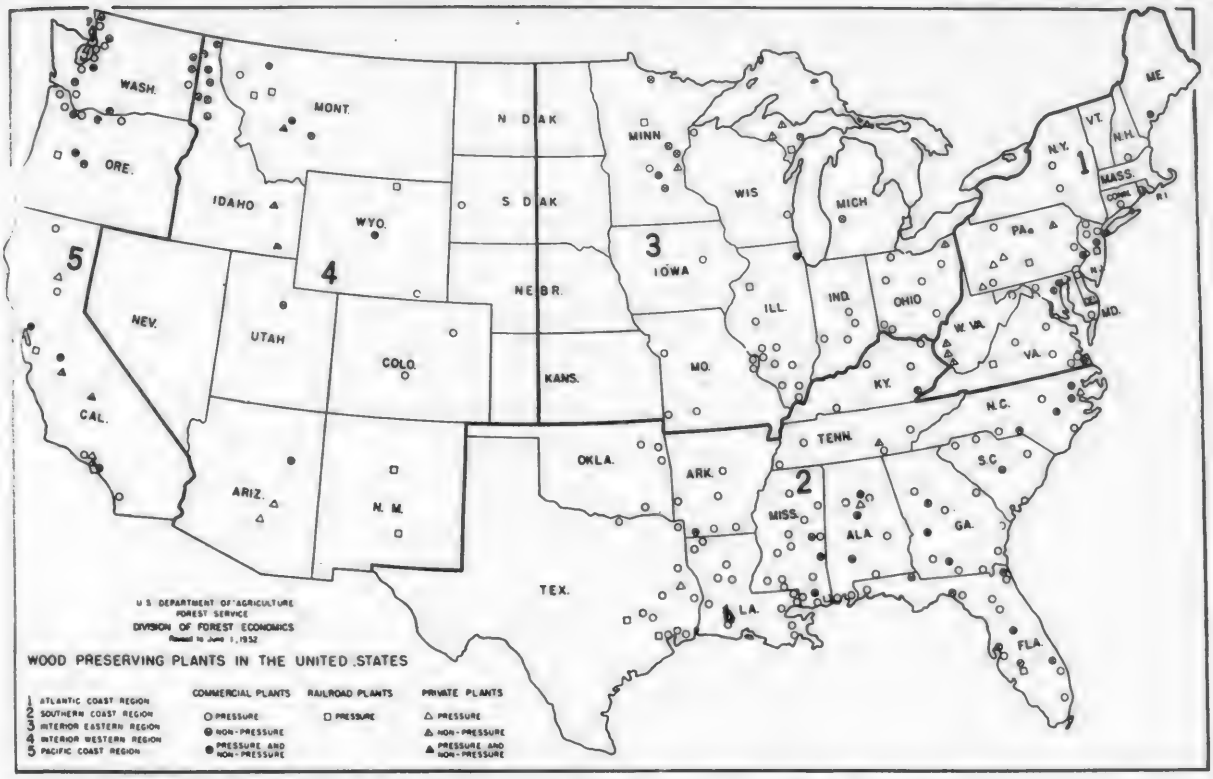

Fig. 2.—Locations of various types of wood preserving plants in the United States.

possibilities for solving some of the problems confronting the wood preservation industry.

The use of sonic and ultrasonic vibrations to improve the treatability of wood has also been given consideration. No practical applications have come to our attention, but a report on such a study by McSwain and Kitazawa (65) was released in 1955.

Considerable research has centered around finding specific reaction products that could be used to test for pentachlorophenol. Monie S. Hudson reports that he has tested over 3,000 compounds in his search for a suitable penta indicator. Although certain products seemed to work in vitro, they were not satisfactory on wood. Work describing the development of the crystal violet method for showing the presence of penta in wood was published by Sakornbut and Morrill (82). Although commercial bulletins detailing certain methods for penta are available, there is need for a good technical paper reporting on the advantages and disadvantages of the various methods and containing a comprehensive bibliography on the subject.

V. Activities of Special Interest in Other Societies, Associations, or Technical Organizations

Several activities point to an ever-increasing interest in the problem of producing and popularizing preservative-treated wood.

The American Wood Preservers Institute now has eight field engineers strategically located throughout the U. S. to aid in extension as well as technical work on wood preservation. The change of format of the Wood Preserving News and its publication of timely articles on all phases of wood preservation have saved certain markets for wood and recaptured others that were being exploited by competitive products.

The Southern Pine Association published Architects Bulletin No. 6 (88) on wood preservative and fire retardant treatments, and it has proved extremely helpful to architects and others who wanted to know how to specify treated wood.

The Federal Housing Administration, because of a growing and widespread interest in the prevention and control or decay and termites in residential construction, secured the services of the Building Research Advisory Board of the National Academy of Sciences, National Research Council, to study available information and data on the subject so that the FHA could use the information to revise, if necessary, its minimum property requirements as they pertain to this element of house construction.

The BRAB conducted the study; many agencies, institutions, and private industries contributed data for inspection and evaluation (6); and these data were summarized in a report entitled, "Protection Against Decay and Termites in Residential Construction" (35).

The Northeastern Wood Utilization Council held its annual meeting at New Haven, Conn. in November 1955. A summary of papers, reports, and discussions of this third meeting was issued in August 1956.

The Coordinated Wood Preservation Council of the Southeast met at Raleigh, N. C. in November 1955. A 49-page mimeographed report was issued (32).

The West Coast Crossarm Association was established by 10 crossarm manufacturing firms on July 12, 1955. The Association was formed to pool technical information, conduct research, collect statistics, and maintain high quality standards.

The National Woodwork Manufacturers Association has placed a project with the U. S. Forest Products Laboratory to evaluate water repellency test methods. Several interested producers of treating solutions are cooperating by furnishing chemicals and technical data.

The Douglas Fir Plywood Association is making evaluation tests of fire-retardant treated plywood and is also studying the treatment of plywood with toxic water repellents.

The Western Pine Association is studying the protection of logs in cold

deck storage and doing further evaluation on wood preservatives suitable for millwork.

Three active projects of the Western Wood Preserving Operators' Association are:

a) Cooperative research program on the preservative treatment of Douglas-fir piling with creosote and a 70/30 creosote–coal tar solution.

b) Compilation of service records on foundation and marine piling.

c) Fabrication of treated wood lighting poles.

The California Redwood Association is continuing their study of the serviceability of redwood cooling towers, giving special attention to the nature of tower deterioration and recommending procedures for reducing deterioration.

VI. General Items of Interest

Under this topic we might again stress the work of the BRAB in drawing up a report for the FHA, for it is bound to have considerable impact upon the utilization of wood preservatives and other protective chemicals.

Several items relative to pole production and utilization should be called to the reader's attention. With the widespread interest in pole-type construction, there will no doubt have to be a renewed interest in species other than those commonly used to date. Western larch is becoming an increasingly strong competitor in the premium pole market, and the market for lodgepole pine has increased.

A continued effort is being made to find practical ways to treat Engelmann spruce and other species difficult to treat. Much pole stock is available—it awaits further development of technical information. Exploratory efforts are being made to season large poles in an experimental kiln. Our Intermountain committee member reports that the preliminary results indicate real possibilities exist.

What impact the introduction of plastic poles may have on the production and preservative treatment of wood poles remains to be seen. As with all competition, information on a specific product is always a good sales weapon. The wood industry can well afford to know its facts relative to the costs and merits of wood poles, and perhaps "tell the world" why wood poles are still the most advantageous type of pole to use.

A double-diffusion treatment is coming into increasing use for the "in place" treatment of cooling towers that are found to be decaying after a number of years of use. It consists of separately spraying the inside of a tower with solutions of two chemicals that diffuse into the wood and then react to form a toxic compound of low solubility. Copper sulfate and sodium chromate constitute one combination of chemicals that has been used. The first treatment of this type was made in 1952. It has been estimated that approximately 40 towers containing over 7.5 million board feet of lumber were treated up to January 1, 1956. Some of these towers were treated by the owners and others were treated on a commercial basis by a cooling tower manufacturer. Service records will be needed to determine the effectiveness of the treatment. For a citation on this work, the reader is referred to literature citation (9).

During the year 1955 and until May 1956, at least 26 new pressure treating plants went into operation, with several others having been moved or started up under new ownership. The new plants are: Alderman Wood Preserving Co., Manning, S. C.; Baxley Creosoting & Osmose Wood Pres. Co., Inc., Baxley, Ga.; Bunnell Timber Co., Bunnell, Fla.; Collier Creosoting Co., Beaumont, Texas; Dantzler Lumber & Export Co., Jacksonville, Fla.; Dargan Lumber Manufacturing Co., Inc., Conway, S. C.; Dixie Wood Preserving Co., Dearing, Ga.; Folley Wood Preserving Co., Sumter, S. C.; Forestry Services, Inc., Atglen, Pa.; Hallock Timber Co., Inc., Adams, Wis.; Marshall Wood Preserving Co., Marshall, Texas; McNamee Lumber Co., Bath, S. C.; Mixer Lumber Co., Buffalo, N. Y.; Moyher & Schultz, Inc., Latrobe, Pa.; New England Pole & Wood Treating Corp., Merrimack, N. H.; O. B. Laurent Lumber Co., New Roads, La.; Piedmont Wood Treating Corp., Raleigh, N. C.; Post and Lumber Preserving Co., Quincy, Fla.; L. B. Proctor Lumber Co., Woodbine, Ga.; Reimers–Schneider Co., Inc., Hammond, La.; Thomas S. Roberts, Abbeville, Ala.; Sherwood Treating Co., Winston Salem, N. C.; Stoddard Enterprises, Inc., Bethel, Vt.; S. I. Storey Lumber Co., Armuchee, Ga.; Wood Preservers Inc., Northern Neck Lumber Co., Warsaw, Va.; Waverly Timber Co., Waverly, Tenn.

Transfer plants include: Cape Fear Wood Preserving Co., Fayetteville, N. C.; Columbia Wood Preserving Co., Columbia, S. C.; Olin–Mathieson Chemical Corp., Frost Lumber Division, Shreveport, La.; Wells–Taylor Wood Preserving Co., Inc., Gautier, Miss.

The addition of these new treating plants should increase the availability of treated wood and thus stimulate its use. There is still a great need for properly treated wood to be available in various localities. There is no question but what treated wood is now only available in general in large towns, or in towns where treating plants are located or at least nearby. A strong publicity program backed by stocking of treated wood by retailers on a local level would aid the cause of wood preservation greatly and also be of value to the wood-using public.

With the rapidly increasing use of composition boards (low density, high density, hardboards, chipboards, etc.), their sphere of usefulness is being expanded. These items will reach end uses where preservative treatment will be essential to long and effective life. There is a paucity of literature on this phase of wood utilization and its preservative use potential.

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Review of Chemical Utilization[1]

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Development of chemical uses for bark was a 1956 highlight in the chemical utilization field. Also reviewed are progress in chip utilization, research in extractives, recovery of spent liquors, new pulping methods, basic research in naval stores, increased demand for charcoal, and developments in lignin chemistry.

INTEREST IN THE UTILIZATION of bark for chemicals highlighted the last year in the field of chemical utilization. This interest has been brought about by the widespread installation of barking equipment for sawlogs and slabwood. The word, "silvichemicals," has been coined to include those products extracted from the noncellulosic part of trees.

Although it started originally in the Pacific Northwest, the use of sawlog barking equipment has spread to all parts of the country. In the South there are now 85 sawlog barking and chipping installations, and some 60 additional sawlog barker installations are planned. Approximately 25 slab barkers are now installed at small mills in the South or at central concentration yards located strategically to small mills.

Utilization of Bark

There have been a series of announcements of expansions and new operations for the commercial utilization of bark and its by-products (1, 6, 9, 11).[3]

A new plant costing about $250,000 has been built to extract redwood bark at the rate of 10 million pounds per year (13). In this plant, the bark is cooked with sodium sulfite and soda ash or caustic soda. Potential markets for these products are in oil-well drilling muds, flotation processes, leather tanning, and water purification treatments.

The lignosulfonates from bark have lower molecular weights than those obtained from wood or spent pulping liquor and therefore are more soluble.

In Vancouver, B. C., a new plant has been built to extract hemlock bark to make products with uses similar to those from the redwood extraction plant. This plant is the result of two years of pilot plant operation.

A new low-cost high-grade resorcinol-type phenolic resin intermediate has been announced as in the development stage. Another, myrecitin, a bioflavanoid, with potential critical applications is being extracted from the bark of lodgepole pine.

One report (28) pointed out quite well the barriers, activating pressures, and the prizes to be gained in the recovery of chemicals from wood residues. In two excellent papers, the future of bark as a chemical raw material (127), as well as a brief survey (39) of present bark utilization methods, was presented. Potential markets (16) for southern pine bark also were described during the past year.

Substantial new progress was made on the isolation and identification of chemicals from bark. Hergert (68) contributed an excellent paper on the chemistry of the flavanoids of lodgepole pine bark and, with coworkers (69), on the methylation of dihydroquercetin. A patent (67) was issued, covering a method for the manufacture of β-conidendrin. Kurth has been granted patents on the production of dihydroquercetin (83), on the conversion of dihydroquercetin to quercetin (84), and on a process for the extraction of products from barks (85). Farber (46) was given a patent on the alkali conversion of bark. Adams (22) received a patent for the preparation of rubber-carbon black mixtures from the alkali-soluble fraction of Douglas-fir bark

The loss of the chestnut tannin industry has renewed efforts to recover tannins from barks. Western hemlock bark extraction rates have been studied with water (110) as a solvent and with dilute alkaline (111) solvents, in order to recover its tannin for the production of leather. Research (10) is underway to convert Michigan's hemlock wastes into leather tannin. Humphreys (74) has shown a correlation of tannin content of pine bark with a tannin-formaldehyde precipitate. Mayer (93) reported on the chemical constitution of catechins from the barks of oak and chestnut. Reddi (105) studied the tanning of sole leathers from bark materials.

Two patents were issued for the physical utilization of bark. Heritage (70) has a method for the production of cork-bound, hot-pressed boards or molded articles. Risi (107) has a patent for the production of boards from softwood barks.

Increased Chip Use

To increase the supply of pulp chips, sawmill residues (72, 75) are being utilized. Bark removal constitutes one of the biggest problems (73) connected with this utilization. Chemical debarking (40, 129) has played an important role in the utilization of hardwoods for pulp chips. Just what makes chemical debarking successful (19) is not yet understood. The quality of the chips (35, 86) from wood wastes is important inasmuch as only a low percentage of bark can be tolerated with the pulp chips.

The availability of bark which has resulted in the developments just described has been made possible only by the need for pulp chips for the expanding pulp and paper industry. In the South alone there are now more than 400,000 cord equivalents of pulp chips produced annually.

Many pulp mills are now supplying their wood requirements from chips produced from the residues of sawmills, veneer plants, and planing mill, and box factory residues. To obtain an idea of the economics of chip production (6), sawmills as small as those cutting 10 million feet a year now have installed chippers. A chipping installation can be made for less than $50,000. It has been reported to be paid off in a year.

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[2] Maintained at Madison, Wis., in cooperation with the University of Wisconsin.

[3] Number in parentheses refer to literature cited.

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Sawmills having an annual capacity of 25 million board feet can profit by the installation of whole log barkers and chippers. A 60-inch mechanical barker installation will cost about $200,000 whereas a hydraulic barker would cost up to $750,000. Where log barkers are used lumber production is increased up to 10 per cent with added high-grade recovery and savings in saw life and mill clean-up.

Sawmill chips are now transported more than 300 miles to the pulp mills. The weight of chippable wood residue developed from sawing 1,000 board feet of lumber (56) in terms of dry wood substance are for Douglas-fir, 0.449 ton; for the true firs, Sitka spruce, and western hemlock, 0.369 ton; and ponderosa pine, 0.313 ton. An interesting utilization development should be mentioned: One western kraft mill now is pulping sawdust in continuous equipment. The pulp is bleached and added to the furnish in the company's paper mill.

The installation of these chippers has been brought about because the pulp and paper industry has enjoyed another vigorous year of production and growth that reaffirms its importance to the economy.

Growing Consumption of Paper

The American public consumed 29,883,000 tons of paper and paperboard in 1955. In spite of rising population, the per capita consumption was raised from 384 pounds in 1954 to 418 pounds in 1955. Total production of wood pulp for all uses in 1955 was 20,829,730 tons. To produce this much pulp required about 33,332,000 cords of pulpwood. Consumption of hardwood pulpwood was 5,621,720 (17) cords, 17 per cent of total pulpwood consumption.

Because of the pressure for more raw material for pulp and paper and its influence on potential hardwood use, a breakdown of the consumption of hardwood pulp by region for 1953 is given below.

Region	Hardwood Cords	Distribution of hardwood consumption by region Per cent
Northeast	905,399	20.6
Appalachian	992,415	22.8
Lake States	991,158	22.6
South	1,414,953	32.3
West	76,000	1.7

Predominant hardwood species for pulp are aspen, sweetgum, birch, beech, maple, cottonwood, chestnut, tupelo, oaks, and alder.

Hardwoods are converted to pulp by all the common processes. From a research standpoint, the greatest emphasis has been given to high-yield processes, such as the semichemical, chemigroundwood, and cold soda processes. The latter is now finding commercial acceptance in this country as reported this year (2). One such installation in New York State involves hardwood cold soda pulp as a component of printing papers. Another under construction will make hardwood cold soda pulp for use in newsprint. In still another southern newsprint company, a pilot plant has been built to evaluate cold soda and neutral sulfite semichemical pulps for newsprint.

Cold soda pulp offers advantages of high yield, in some cases almost 90 per cent of the weight of wood. It is made by treating chips with cold caustic by simple steeping, pressure treating, or continuous methods followed by milling the pulp to fibrous form.

Spent Liquor Recovery

One problem which has received considerable attention has been the recovery of the alkali in this process. A paper on this subject, "Recycling Liquor Systems for Cold Soda Pulping," was recently presented at the Annual TAPPI Alkaline Pulping Conference (30). This gives considerable data on the composition and possible solutions for disposal or re-use of partially spent liquors from the process. At the low temperatures used in this process it was necessary to have fairly high chemical concentration in proportion to the amount of chemical consumed. Consequently, the spent or drain liquor from the cooks contains a relatively large amount of caustic which must be reused. Associated with the caustic consumed is about an equal amount of organic matter extracted from the wood. The solubilized matter is present with the unused caustic and rapidly builds up to saturation.

Research on recovery processes for other pulping methods continues to receive considerable attention. A new method described as the atomized suspension technique was proposed for neutral sodium semichemical waste liquor recovery (90). In consists of atomizing the spent liquor in the absence of air or other gases into the top of a tower, the walls of which are maintained at a high temperature, and of passing the resulting concentrated liquor in the form of a suspension of droplets in the water vapor as a carrier through successive zones of evaporation, drying, and chemical treatment, as it settles down the tower. Separation of the solids, uncondensable gases, and steam are then effected by simple means. The fundamental aspects of the technique are new and novel and promise an efficient unit process combination of much value. Only pilot plant operations have as yet been attempted.

Research on semichemical pulping spent liquor recovery systems is important because accumulation of spent liquor is a limiting factor in the utilization of hardwoods, both in terms of economics and the ever increasing necessity to avoid stream pollution. Work reported on this subject during 1955–56 includes the following:

1. A feasible process for recovery of neutral sulfite semichemical spent liquors.
2. A summary of research on neutral sulfite semichemical spent liquors.
3. A brief description of the Zimmerman process.
4. A review of some of the most recent methods of byproduct production and stream pollution abatement in kraft and sulfite mills.
5. A review of waste disposal methods being used at different mills. Well illustrated.
6. A brief report of the activities of a number of pulp mills in Wisconsin on sulfite spent liquor disposal.
7. A study of pulping and purification procedures to produce pulps with high purity for the purpose of relating certain properties of pulps to the properties of pulps to the properties of cellulose nitrate.

Pulping Methods

One of the more promising recent efforts in pulp and paper research relates to the production of groundwood-like pulps from wood chips rather than from bolts of wood used in traditional stone grinding. The prospects of using chips rather than bolts is significant to the forester. This concerns both softwoods and hardwoods. The pulps can be produced by treating the chips lightly by the neutral sulfite semichemical process, the cold soda process, by various combinations of treatments, or by no treatment at all followed by breakdown in screw presses, disk mills, roller mills, or other devices, on a continuous or batch basis. It has been suggested that these pulps be referred to as "chip groundwood" pulps.

A principal problem in making chip groundwood pulps has been to obtain a proper balance of strength and opacity required for the product. One approach has been to consider this pulp as a third component in newsprint, where it could substitute partly for the long-fiber chemical pulp because of its strength, and partly for the groundwood because of certain similarities to groundwood pulp. This would permit the expansion of a mill at a given location by the addition of

units to produce special hardwood pulps. The minimum economical mill size, often an important factor in mill expansion, may be smaller for a mill that produces this type of pulp than for one that produces chemical pulp.

A series of reports (12) has been prepared summarizing work recently completed or under way at a number of institutions in the United States and Canada. These include fundamental research concerning the linkage between glucose and mannose in slash pine alpha cellulose, a study of the order and nature of the aspen wood hemicellulose removed during a neutral sulfite semichemical cook, and applied research on pulping of semichemical hardwoods and the bleaching of hardwood pulps.

Basic Naval Stores Research

Naval stores research has led to the establishment of 20 central gum-cleaning, steam-distillation plants that process approximately 90 per cent of all the pine gum produced for turpentine and rosin. Recently basic research has been undertaken to determine more of the individual components in pine gum. One of these, palustric acid (8), was found to be 18 per cent of the resin acids in gum resin. The discovery of this new chemical is expected to improve the production of gum resin and also paper size, the largest single use for rosin.

Peroxides may be produced from terpenes and their derivatives. Several of these peroxides have been tested and found entirely satisfactory for use in the production of synthetic rubber at low temperatures. From the α-pinene of gum turpentine a chemical intermediate, myrcene, can be converted into such varied materials as synthetic resins, perfumes, and synthetic rubber (18).

Maleopimaric acid, an addition product of maleic anhydride, and levopimaric acid is made directly from crude pine gum. This new product offers possibilities in the preparation of plasticizers, resins, printing inks, and emulsifying agents.

With the recent announcement of a new synthetic rubber made primarily of isoprene, the basic molecular unit of natural rubber, a method developed for producing isoprene from the terpenes of turpentine takes on added interest. The terpene molecule is split into two molecules of isoprene by a high resistance iron wire heated to about 1,400° F.

Rising Charcoal Demand

During the past year a large charcoal plant that will produce 26,000 tons of charcoal per year has been under construction near Burnside, Ky. (9). The estimated cost is $2,290,000. It will use chips as the raw material, and the charcoal will be briquetted.

The demand for charcoal is still increasing, and many new installations of small cinder block and beehive steel kilns have been made. The number of briquetting plants has also increased to approximately 20, since the preference for the domestic and recreational market throughout the country tends toward a briquetted product.

Not only has domestic charcoal production increased but activated carbon production has risen (3). It was 32 million pounds in 1940 but it reached 95 million pounds in 1955. Activated carbon is used to purify sugars, water, antibiotics, chemicals, and pharmaceuticals. Activation procedures may be either of two types, pyrolysis or oxidation.

In activation by pyrolysis, a carbonaceous material is mixed with a suitable chemical such as calcium or magnesium chloride and the mixture carbonized by heat. Activation by oxidation depends upon carbonization at elevated temperatures in the presence of oxidizing gases such as steam.

Industrial and medical uses of carbohydrates have been discussed recently (117).

Wood Residue Hydrolysis

Interest in the hydrolysis of wood residues has increased lately because of the possibility of producing furfural from the 5-carbon or pentose sugars and of producing hydroxymethylfurfural and levulinic and formic acids from the 6-carbon or hexose sugars. Furfural is a major industrial chemical used in large quantities in the manufacture of nylon. Furfural also may be used to produce lysine, one of the essential amino acids (4). At least two companies are developing a process for the production of this amino acid, a mixture of DL–lysine. Essential amino acids are vital to healthy body functioning and unlike nonessential amino acids they cannot be synthesized by the body.

A $1.5 million dollar plant for lysine production has been announced for late 1957 or early 1958. The long-range outlook for the amino acid is a large market in cereal grain breakfast cereals, bread, and similar products which make up 60 per cent of the lysine deficient foods.

The largest sources of organic material already in solution and awaiting chemical processing are the spent liquors of pulp mills. Most of the vanillin presently produced by two companies is made from spent sulfite liquor.

A recent announcement stated that a two-million pound per year plant will be built to produce dimethylsulfide from spent kraft liquor (16). Sixty pounds of dimethylsulfide may be obtained per ton of pulp. The price should be approximately 15 cents per pound in carload lots. Technical grade of dimethylsulfide is being recovered from sulfate tall oil operations. Its most promising use, other than as an odorant or counterordorant for industrial use, is as an organic chemical intermediate. It has possibilities for use in synthetic plastics, fibers, and selective solvents.

Showing promise as an antioxidant for resins and rubber, particularly oil-extended GR–S polymers (121) is a new product β-conidendrol (65) produced from conidendrin present in substantial amounts in western hemlock sulfite spent liquor (87).

An iron complex (17) is being made from spent sulfite liquor and sold as an agricultural spray. Ammonia base sulfite spent liquor, in contrast to calcium base sulfite liquor, may be combined with phenolformaldehyde resins to give an effective binder for woody boards (71). Its use would be particularly applicable to the manufacture of plywood overlay papers.

Spent sulfite liquor has been effective for the treatment of agricultural crops suffering from excess boron (121) in the soil or irrigation waters. The sulfite spent liquor is added directly to the irrigation water. Soils treated in this manner have resulted in up to 10 per cent increased yields.

An aerobic fermentation has been developed employing a mixed bacterial culture capable of reducing the decomposable organic material of spent sulfite liquor 80–90 per cent. The bacterial cells that grow upon the organic material contain 66 to 74 per cent protein, and complete analyses of the dry cells indicated that they contained all the essential amino acids in relatively high concentrations. They also contained most of the B–complex vitamins. Yields as high as 220 pounds of dry protein material have been obtained per ton of pulp (24, 25, 26).

Lignin Chemistry Research

As a part of this review, the recent developments in lignin chemistry are brought up to date.

Model compound studies have been reported along several lines in lignin chemistry research. Richtzenhain and Alfredsson (106) synthesized a number of lignin model compounds of the flavan and coumarone series and submitted them to both neutral and acid sulfite cooking. Coumarone compounds with benzyl alcohol side chains sul-

fonated with acid sulfite solutions at room temperature, and 4–hydroxy–3′, 4′, 8–trimethoxyflavan at 130° C. yielded a disulfonic acid by ring splitting.

Stumpf and Rumpf (119) prepared guaiacyl glycerol and found that it sulfonated with sodium bisulfite to an α–sulfonic acid. The quinonemethide reaction noted earlier was applied to a number of model compounds by Adler and Stenemur (23), and the spectrophotometric properties of the products compared with those of reaction products of "isolated native spruce lignin."

Mikawa and co-workers (95) submitted thiolignin and a number of model compounds to the Mannich reaction with dimethylamine and concluded that 25 to 40 per cent of the phenolic content of thiolignin belongs to unsubstituted guaiacyl nuclei. The same authors (96) studied the reactions of model compounds under kraft pulping conditions and proposed a new mechanism of kraft pulping which involves three reactive groups in lignin.

Dimeric cinnamyl alcohol was prepared by Freudenberg and Ahlhaus (49) for use as a model in dehydrogenation studies. Kratzl and co-workers (79) similarly prepared a large number of C14 labeled model compounds for continuing studies on lignin and its reactions. Kratzl and Klein (80) subjected purified spruce lignosulfonate material and several sulfonic acids of guaiacylpropane model compounds to Hibbert's ethanolysis procedure and found the same products that Hibbert found with sprucewood. All model compounds were not amenable to ethanolysis, and some required much stronger conditions than those employed by Hibbert.

Kratzl and Schweers (81) subjected hardwood lignin and dehydropolymerized p–hydroxycinnamyl alcohol to ethanolysis and obtained the ethanolysis products expected on the basis of previous work. The products obtained from the polymerized p–hydroxycinnamyl alcohol were identified by comparison with synthesized models. Sprucewood and "isolated native lignin" were reacted with quinone monochloroimide by Gierer (59) who obtained the same indophenol obtained from guaiacol. Similarly, aspenwood yielded a mixture of the same indophenol and one which could also be obtained by reaction of either syringyl alcohol or pyrogallol 1,3–dimethyl ether with quinone monochloroimide.

Pearl (98) synthesized a number of lignin model compounds related to diethylstilbestrol with two C_6–C_3 units linked through their α–carbon atoms. These models were submitted to alkaline nitrobenzene and cupric oxide oxidation (99) and yielded the same oxidation products that were obtained from analogous oxidations of coniferous lignosulfonate materials. Thus, it seems probable that a portion of the lignin complex might contain a similar linkage.

Freudenberg (51) has reviewed the extensive work in his laboratory on the biosynthesis of lignin from coniferyl alcohol, and Aulin–Erdtman and Hegbom (29) have compared Freudenberg's DHP (dehydrogenation polymer) and its sulfonate with analogous coniferous lignin preparation by means of the $\Delta\epsilon$ method. One the basis of model compound studies, the latter authors conclude that the DHP differs quantitatively from lignin with respect to a number of structural elements and groupings. Freudenberg and Schumacher (50) reported an extensive study of the ultraviolet absorption spectra of natural and synthetic lignins and model compounds including sulfonic acids of all, but their conclusions did not always correspond with those of Aulin–Erdtman and Hegbom.

The transformation of C14–labeled aromatic monomers into lignin residues which yield phenolic aldehydes upon nitrobenzene oxidation was studied by Brown and Neish (36). They also described a new chromatographic procedure for the separation of the phenolic aldehydes on diatomaceous earth columns. Brown and Neish also (37) demonstrated that each type of lignin polymer has a corresponding aromatic monomer.

Radioactive glucosides related to coniferin were prepared by Fuchs (52) for use as lignin precursers. In carefully controlled experiments, Siegel (115) was able to show that the product of oxidation of eugenol by means of peroxidase-hydrogen peroxide gave lignin color reactions only when prepared in the presence of cellulose or a cellulose derivative.

Srinivasan and co-workers (116) studied the production of shikimic acid by bacterial cultures of *Escherichia coli* grown on variously labeled C^{14} D-glucose as the only carbon source, and they were able to determine the route of formation of the several carbon atoms of shikimic acid. Eberhardt and co-workers (41, 42) have continued their studies on the possible relationship of methyl p–methoxycinnamate to lignification in plants and the role of shikimic acid in lignification.

Reaction with Water Studied

The reaction of wood with water was investigated. Goldschmidt (61) heated western hemlock wood and "isolated native lignin" with water at 175° F. and examined the ether soluble materials formed. He found vanillin, vanilloyl methyl ketone, guaiacyl acetone, coniferylaldehyde and p–coumaraldehyde and discussed his findings with respect to the nature of western hemlock lignin.

Kratzl and Silbernagel (82) in continuing studies treated hardwood and softwood and a number of isolated lignins and hardboards with water at temperatures up to 200° F. and determined the effect of such treatment upon the aldehyde yields obtained on subsequent nitrobenzene oxidation. Gustafsson and Soila (63) heated spruce and birch woodmeals at 150° F. with water at various pH values and determined the changes in the lignin by the nitration reaction of Gustafsson and Anderson (62). These authors noted that such heating does not appreciably block the groups in lignin responsible for the production of 4,6–dinitroguaiacol.

Arlt, Sarkanen, and Schuerch (7) treated sprucewood meal with 0.1 *N* hydrogen chloride in a 4:1 mixture of chloroform and ethanol at 60° F. and characterized the ethanol spruce lignin formed. Traynard and Eymery (122, 123) extracted lignin from aspenwood, sprucewood, straw, *Ephedra,* and gingko by means of hydrotropic solvents and characterized the lignins obtained. These authors attempted to correlate chemical composition with plant taxonomy.

In studying the nature of the lignin removed during a neutral sulfite semichemical cook of aspenwood, Stone (118) removed samples of cooking liquor at various times during the cook and oxidized them with alkaline nitrobenze. Quantitative determination of the aldehydes indicated that the yield of vanillin was approximately constant throughout the cook, whereas the syringaldehyde yield continually increased.

Residual lignins in various eucalypt and pine pulps were studied by Bland and Stamp (34) who oxidized the pulps with alkaline nitrobenzene and found that the residual pulps did not differ fundamentally from the lignin in the original wood. Acetovanillone and acetosyringone were determined in addition to vanillin and syringaldehyde.

Vanillin, p–hydroxy-benzaldehyde, and syringaldehyde were added to several annual plants before alkaline nitrobenzene oxidation by Roadhouse and MacDougall (108) who found considerable loss in the aldehydes after oxidation. Losses were usually greater with young tissues than with older tissues. The presence of p–hydroxybenzaldehyde does not increase with age, vanillin increases slightly, and

syringaldehyde increases very markedly.

Pearl and Beyer (102) isolated a number of new compounds from cupric oxide oxidation mixtures of lignosulfonate materials by paper partition and adsorption chromatographic techniques. Bland and co-workers (32, 33) employed borate papers for quantitative separation of lignin related materials. Sohn and Munder (115) investigated the origin of *trans*–4, d′–dihydroxy–3, 3′–dimethoxystilbene, a product formed when spent sulfite liquor is heated with alkali under pressure. These authors demonstrated that this stilbene is formed from an acidic component of wood which can be extracted from sprucewood by aqueous acetic acid. The stilbene can also be obtained by direct alkaline reaction of sprucewood.

Cabott and Purves (38) studied the effect of temperature and acidity in the pulping of carbohydrate-free spruce periodate lignin. They treated the lignin with buffer solutions from pH 1 to 10 at temperatures of 100° to 150° F. and subsequently submitted the lignins to a calcium-base sulfite cook. From their results, they concluded that the temperature and acidity of a commercial sulfite cook is adequate to form additional carbon to carbon bonds, presumably as cross links, in a reaction which competes with the tendency of the lignin to dissolve by direct hydrolysis and by sulfonation.

Preliminary reports of a comprehensive investigation of the nature of aspen lignin have been given by Pearl and co-workers (101, 102). Studies were reported on aspenwood, aspen spent sulfite liquor, aspen "isolated native lignin," and aspenwood extractives, that indicated the nature of aspen lignin does not agree with traditional concepts of lignin, even hardwood lignin.

New Analytical Procedures

A number of analytical procedures were reported for use in the study of lignin chemistry. Mathers and Pro (92) cleaved methoxyl to formaldehyde, treated with chromotropic acid, and determined the color spectrophotometrically. This procedure is specific for methoxyl. A volumetric method for the determination of vanillin and/or syringaldehyde in the presence of other carbonyl containing products of lignosulfonate oxidation was reported by Fowler, Kline, and Mitchell (48). The procedure is based on the difference in rates of oxime formation of vanillin and the other compounds.

Wacek and co-workers (127), in studying the stability of the methoxyl groups of several lignin preparations toward alkali, determined the methanol split off by their previously reported procedure (128) which was based on the conversion of the methanol to methyl nitrite and the determination of the latter idometrically.

The quantity and the nature of the various groupings in the lignin complex were investigated by many authors. Ekman and Enkvist (44) tested a number of lignin preparations for strong acid (carboxyl) groups, weak acid (phenolic) groups, and carbonyl groups, and found considerable differences. The study was carried further by Enkvist, Alm, and Holm (45) who compared the weak and strong acidic groups of a large number of lignin preparations by four different procedures. Although all methods did not give the same values, the authors indicate the most probably correct ones.

Mikawa and co-workers (96, 97) studied the phenolic hydroxyl content of gymnosperm and angiosperm lignosulfonic acids. They concluded that these lignosulfonates (and parent lignins) contain two types of phenolic hydroxyl groups. One type is conductometrically titratable, and the other type is untitratable. Ratios varied from 1:1 in birch lignosulfonic acid to 3:7 in a corresponding gymnosperm lignosulfonic acid.

Gardon and Mason (54, 55) fractionated lignosulfonates from spent sulfite liquor and studied their behavior as polyelectrolytes. They concluded that the degree of molecular branching of the high molecular-weight lignosulfonates is greater than that of the low molecular-weight fractions. McCarthy and co-workers (47) have continued their studies on the fractionation of lignosulfonates of coniferous origin. They found that the molecular weights of the lignosulfonates range from a few hundred to about 100,000, average about 10,000 to 20,000 and are distributed somewhat differently in the several preparations studied. In the same laboratories, Glennie (60) succeeded in isolating monmeric crystalline lignosulfonates.

Recovery of Lignosulfonates

Recovery and use of lignosulfonates from spent sulfite liquors has again been given considerable attention. Van Blaricom and co-workers (124, 125) have reported the selective adsorption of lignosulfonic acids and their salts on porous ion-exchangers having phenol-hydroxyls as the effective groups and have also described the preparation of an anion-exchanger having tertiary amines as the only effective group. In studying the color formed by lignosulfonates in the presence of ferric iron, Ganczarczyk (5) found that lignosulfonates could be completely eliminated from solution by precipitating the lignosulfonate-iron complex with calcium hydroxide.

Salvesen and Browning (109) report a procedure for reinforcing polymeric butadiene synthetic rubber with partially desulfonated lignosulfonate material. The fluidized pyrolysis of spent sulfite liquor was studied by Rabinovitch and co-workers (103, 104), who studied the chemical recovery at different temperatures for different contact times. Work has continued on the use of lignosulfonate in leather tanning (72, 40, 71), drilling mud compositions (89), cement manufacture (88), and as a mold nutrient (78).

Several important reviews have covered the chemistry and physiology of lignin formation (113), the utilization of spent sulfite liquor (91), lignin (64), and the lignans (66).

Advance in the chemistry of lignin was given considerable impetus this year by two lignin symposia. The first was sponsored by the Cellulose Division of the American Chemical Society at its 130th National Meeting in Atlantic City, N. J., Sept. 19 and 20, 1956. The second was the Third Lignin Round Table held at the Institute of Paper Chemistry, Appleton, Wis., Sept. 24–26, 1956. The first symposium included papers in all branches of lignin chemistry while the second was concerned primarily with the biochemistry of lignin. Papers given at these symposia will be published in the near future and will be covered in the next report.

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Status of Wood Drying in 1956[1]

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Trends in various aspects of wood seasoning are discussed. Included are developments related to air drying and kiln drying, as well as special seasoning processes. Dry kiln clubs and secretaries are listed, and a bibliography is given of publications in 1955 on wood drying processes and equipment.

Introduction

IN 1954, THE WOOD DRYING DIVISION of the Society under the chairmanship of Raymond C. Rietz prepared a detailed report on the current status of wood drying. That report was published in the February 1955 issue of the FOREST PRODUCTS JOURNAL. Marked changes in the field of wood drying have not occurred since that time although, in general, the trends that were indicated as occurring then have continued. The present status in the field of seasoning therefore is still well reflected by the 1954 report except that additional, or in some cases less, emphasis could be given to certain features. It is the purpose of this present report to call attention to these details.

[1] Members of the Wood Drying Division contributing to this report are: L. D. Espenas, Chairman; S. B. Preston, Vice-Chairman; R. C. Rietz, Pat Williams, Jr., F. W. Guernsey, R. S. Marlatt, P. H. Lane, H. H. Smith, H. B. Gatslick, A. C. Knauss, W. J. Delmhorst, F. E. Dickinson, H. J. M. Jorgensen, III, E. D. Marshall, H. Rhodes, and R. W. Shepherd.

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Air Drying

The trend towards package handling as a means of reducing yarding costs continues. This trend is evident not only in the larger plants but in the smaller plants as well. Many operators who have not yet changed are planning to revise their yarding systems within the next few years. Along with the package handling system, the installation of sorting and stacking equipment is being given equal attention as a means of reducing handling costs.

The storage of green lumber prior to kiln drying is closely allied to air drying. The use of sheds for such storage to prevent the starting of drying defects is receiving much more attention, particularly in the furniture industry.

The use of end coatings on logs and lumber is gradually increasing. As losses from end checks and splits become evaluated, probably the use of end coatings to reduce these defects will increase. While the primary purpose of an end coating is to reduce losses from checks and splits, the improved appearance of square and smooth trimmed lumber with an attractive end finish has served in the West as an additional incentive for expanding the practice. In this area, air drying is not a general practice but the coating is applied to green lumber prior to shipment and it offers protection during transit and in storage at the destination.

In between conventional air drying and kiln drying are air drying with forced circulation, the wind-tunnel driers and the pre-drier, the latter two being essentially low cost kilns operating with low temperatures and large air volumes. All of these are believed to offer definite economic possibilities and more interest in them is generally evident. A few limited studies have been made and more studies are in progress. The systems may be considered either as an alternate to air drying or as an alternate to additional kilns to increase

the output of kiln-dried lumber with a given battery of kilns. As an alternate to air drying, the principal advantage is reduced time and with it, the advantages of a consequently smaller inventory. There is also the possibility of better drying results with controlled low temperature drying with some species and items such as oak, bowling pin blanks, etc.

In the East and South, the interest in these systems is to replace air drying prior to kiln drying. This is also true in the redwood region of the West. In the Douglas-fir region, however, the interest stems primarily from green mills seeking low-cost methods of reducing shipping weights in dimension and common lumber, which in times of low or dropping lumber prices can spell the difference between profit and loss. Installations of this kind could well be a prelude to more kiln drying.

An interesting application of the pre-drier was made in the ponderosa pine region. Faced with the need for more kiln capacity but feeling unable to install additional kilns, a company constructed a pre-drier over the green storage tracks ahead of and adjacent to the kilns. Using second hand equipment and constructing a shed-type of building from structural timbers and low grade lumber on hand, the cost of the pre-drier was well below the cost of an additional kiln and its use boosted the output of the kilns by substantially more than an additional kiln. Furthermore, if there has been any change in the quality of drying, it has been for the better.

Kiln Drying

In new kiln installations at smaller plants, the trend to package loading continues in spite of some of the disadvantages. There seems to be a trend to increase holding capacity, creating long air travel which with inadequate baffling could cause drying quality to suffer. The possibility of induced warping, caused by misalignment or loss of stickers, necessitates extreme care in handling packages.

Perhaps one of the more significant developments in kiln design has been that of prefabricated dry kiln buildings. In general, these have been of small holding capacity and probably they will find their greatest application at the smaller plants. The buildings are made up of panels having a metal interior and exterior separated by structural members and insulation, and overlapping vapor-tight joints. It can be hoped that experience with this general type of construction will lead to improvements in larger kilns, which would provide longer building life and lower heat losses. The more vapor-tight construction can lead to additional steam economies by making it more possible to control humidity with less steam spray.

The availability of the gas or oil fired boiler that may be purchased as a "package" has been encouraging to the installation of kilns at small to medium sized plants. Often the kiln and boiler are purchased together as a package.

The increasing use of mill residues for pulp and wood composition board has made a great impact on the wood industries. It is felt even in the field of wood drying. In general, it means less low-cost fuel for steam generation and consequently a greater awareness of heating costs in kiln drying and of the need for reducing heating requirements. More progress is needed in this aspect of wood drying. It would seem that this development would stimulate interest and improvements in the so called direct-fired or furnace type of kilns. Based only on a few personal opinions, however, this does not seem to be the case. Interest in these kilns seems to have reached a peak with the trend returning to steam as a source of heat and humidification. The dwindling availability of residues for fuel could lead to more interest in part-time operation of kilns.

New schedule developments by research groups seem to be at a standstill. There is, however, a more extensive use by industry of available information, and modifications of schedules to fit the needs of various species and items, both for the purpose of reducing degrade and of obtaining moisture quality control. Undoubtedly, both of these are due to the activities of the dry kiln clubs and short courses in kiln drying. Wherever held, short courses and kiln club meetings have been well attended. The demand for quality drying stimulates a continued and increasing interest in these activities.

Relatively few seasoning degrade studies have been made and published. Much of what has been done has been by research agencies. Industry is becoming more interested in air-drying and kiln-drying degrade and the causes for them. As more information of this kind becomes available, more can be expected in the way of schedule modifications to reduce degrade. A recent study in the interior of British Columbia has shown less degrade in kiln drying than in air drying.

Closely allied with a greater awareness of degrade is that of the need for moisture quality control. More plants are putting some type of moisture quality control program into effect. This applies to both lumber producing plants and lumber consuming plants.

Also along the lines of moisture control, two reliable companies have developed electric moisture meters that are used to determine the moisture content of lumber in the kiln during the drying. Although the two use different electrodes and somewhat different meters, both measure electrical resistance. Each kiln is equipped with a number of electrodes which are driven into selected pieces within the kiln loads. Lead wires from the electrodes are installed in the central meter located in the control room. To determine the moisture content, the kiln operator needs only to press the appropriate buttons or switches. Temperature corrections are provided. These instruments are being well received in the industry.

Equalizing treatments as a part of the regular drying schedule are becoming more of a standard practice, especially in the hardwood producing regions. Conditioning treatments are also receiving more attention, in the softwood industry especially for the upper grades and laminating stock.

Commercial acceptance of high temperature kiln drying has not yet occurred. Interest in this method remains at a high level, however, and laboratories as well as industry await the results of current research in this field by the Canadian Laboratories. Recent results with western hemlock appear encouraging.

The present interest in high temperature kiln drying was started largely from observations on European practices. Other European kiln designs also attracted attention but this seems to have subsided.

Special Drying Processes

The use of chemicals to control surface checking has been slowly expanding. In the softwood producing areas, the application is for thick material. With the increasing popularity of plank and beam construction, and in the greater use of prefabricated trusses, the possibility of more use of chemicals can be expected. In the hardwoods the application is for woods that are normally quite difficult to dry without checking. The emphasis being towards quality drying in general, a greater use of chemicals can also be expected for hardwoods.

Other than the reported development by a Swiss concern of a high frequency drying unit, there are no reports of new trials of special drying processes.

General

For the benefit of Society members who are not now participating in any kiln club activities but would like to

participate, a list of the clubs and the current secretaries, prepared by the U.S. Forest Products Laboratory, is appended. In addition to this list, there is also an active club in British Columbia, the Vancouver Island Dry Kiln Club. Unfortunately the secretary's name is not available at this writing.

Central Calif. Dry Kiln Club: Harvey H. Smith, Sec.-Treas., Calif. Forest & Range Exp. Sta., P. O. Box 245, Berkeley 1, Calif.

Delta Kiln Drying Association: Nick Hicks, Sec.-Treas., E. L. Bruce Co., Memphis, Tenn.

East Oregon-South. Idaho Dry Kiln Club: George Moatz, Sec.-Treas., % Mt. Emily Lbr. Co., La Grande, Ore.

Grand Rapids Lumber Seasoning Clinic: Charles E. Kindel, Chm., Kindel Furniture Co., 100 Garden St., S.E., Grand Rapids, Mich.

Keystone Kiln Drying Association: Prof. Wm. Nearn, Sec.-Treas., Wood Utilization, School of Forestry, Pennsylvania State University, University Park, Pa.

Midwest Wood Seasoning Association: J. E. Nolan, Sec., Suite 820, 332 S. Mich. Ave., Chicago 4, Ill.

New England Kiln Drying Association: Prof. J. Harry Rich, Sec.-Treas., University of Massachusetts, Conservation Bldg., Amherst, Mass.

Ohio Valley Kiln Drying Association: C. W. Hefner, Sec., National Cash Register Co., Dayton, Ohio.

Redwood Seasoning Committee: Douglas Shore, Sec., Arcata Redwood Co., Arcata, Calif.

Southeastern Ark. Kiln Drying Assn.: Vernon Heird, Sec., Ben Pearson, Inc., Pine Bluff, Ark.

Southeastern Dry Kiln Club: Prof. A. C. Barefoot, Sec.-Treas., School of Forestry, North Carolina State College, Raleigh, N. C.

Southern Calif. Lumber Seasoning Assn.: Robert P. Inglis, Sec.-Treas., Associated Molding Co., 7125 Telegraph Rd., Los Angeles 22, Calif.

South. Oregon–North. Calif. Dry Kiln Club: Grant A. Hosford, Sec.-Treas., 903 Yama St. Yreka, Calif.

Southern Wood Seasoning Association: Prof. J. B. Huffman, Sec.-Treas., College of Agr., School of Forestry, Univ. of Florida, Gainesville, Fla.

Southwest Lumber Seasoning Club: Mack Frost, Sec.-Treas., % Kaibab Lbr. Co., Fredonia, Ariz.

Tennessee Valley Kiln Drying Assn.: Prof. G. B. Shivery, Sec.-Treas., P. O. Box 1071, Knoxville, Tenn.

Texas Dry Kiln Club: E. D. Marshall, Sec.-Treas., 541 Humason Ave., Lufkin, Texas.

Wash.–Idaho–Montana Dry Kiln Club: Phil Lantzy, Sec.-Treas., Lincoln Lumber Co., Lincoln, Wash.

West Coast Dry Kiln Club: Doyle L. Van Deventer, Sec.-Treas., Broughton Lumber Co., Underwood, Wash.

Wis.–Michigan Wood Seasoning Assn.: Hereford Garland, Sec.-Treas., Forestry Research Div., Mich. College of Mining & Tech., Houghton, Mich.

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Wood Technologists in the Forest Products Industries

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Reports results of survey of recent graduates in wood technology, utilization, and forest products curricula. Studied were current fields of employment and duty functions, evaluation of curricula, and experience in obtaining employment. Findings indicate present challenges facing industry and education in fulfilling needs for adequately trained technical personnel.

FOLLOWING THE 1955 ANNUAL MEETING in Seattle, the Industry–Education Division of FPRS undertook a survey of recent graduates in wood technology, wood utilization, and forest products to find: 1) how they are doing on their current jobs; 2) what they think of their college education; and 3) their experience in obtaining employment. A questionnaire was framed and sent to 33 colleges offering degrees in these fields for distribution to graduates of approximately the last 15 years.

An oral report of preliminary results was presented at the Asheville meeting in June 1956. Returns were received from 168 men who had received their B.S. degrees between 1946 and 1955, and from 24 graduating from 1935 through 1944. The median age of respondents was 31 years. The 192 returns (approximately 40 per cent of those sent out) included graduates from 27 colleges and universities in the U. S. About 40 per cent of those answering the questionnaire had earned one or more advanced degrees—Master's or Doctor's.

Current Employment

These graduates are currently employed by various forest products industries, as indicated in Table 1. No pattern of industrial employment was noted except that the more actively developing segments of the industry employ proportionately more of these technically-trained men.

Table 1.—FIELDS OF EMPLOYMENT

Current Employer	Per cent
Lumber and Integrated Operations	26
Wood Products Manufacturers	11
Associations, State and Federal Agencies	10
Plywood and Veneer Manufacturers	9
Chemicals and Allied Industries	8
Educational Institutions	7
Furniture Manufacturers	7
Pulp and Paper Companies	7
Fiber and Particle Board Manufacturers	6
Research, Wood Preserving, and Logging Companies	9

As would be expected, large companies engaged in primary manufacture of lumber, pulp and paper, and veneer and plywood represent the major employment. Surprisingly, however, 20 per cent of the responses were from men in service organizations—associations, public agencies, educational institutions, and research organizations. Approximately 4 per cent were working in fields unrelated to the wood industries.

A classification of duties of recent graduates is presented in Table 2. Basis for classification was the principal job function described on the returned questionnaire; obviously many men have overlapping duties involving several of the duty categories listed. Heading the list is sales with 22 per cent, followed by research with 21 per cent, and management and supervision with 16 per cent.

If promotion and development is included with research, as it is in many companies, more men would be employed in these areas than in any other, in keeping with the presumed abilities of college-trained technical personnel. Less than 5 per cent are self-employed, owners of businesses, or sons of owners.

Eighty-four percent of the wood technologists stated they were advancing faster than non-technically trained men. This fact could be interpreted as proof that a college education pays off and is not a detriment to advancement when compared to the progress of the "practical" employee. Only 21 per cent of the replies indicated that their employers had a definite plan of advancement. However, 80 per cent expressed satisfaction in their job and 75 per cent stated they had some influence on policy decisions affecting their jobs.

The section of the questionnaire dealing with on-the-job training, or what is often termed "training-within-industry", received a uniform affirmative response of about one-third to the questions:

1. Does your employer have an established training program?
2. Were you trained by your employer for your job?
3. Do others in a similar capacity have this training?
4. Is your employer's training program adequate?
5. Does your employer use the services of universities, institutes, etc., in on-the-job training?

College Education

One of the main purposes of this study was to obtain an evaluation of the various curricula offered in wood utilzation and technology (forest products) by U. S. colleges and universities. Naturally there have been many programs offered during the past 50-odd years which reflect regional needs and changes brought about by developments in the forest products industries. Curricula are not static and reflect faculty thinking at different institutions, tempered by opinions and suggestions of alumni and employers.

Actual course content of a curriculum leading to a degree will differ, then, from school to school and from year to year. Evaluation of instructional programs thus becomes a difficult problem, but evaluation is essential to establish some measure of the success or failures of curricula. Expression of opinion by graduates is not entirely free of bias since it naturally reflects such factors as quality and quantity of instruction, specific course requirements in force in a particular period, and the current demands of employment.

Eighty-five per cent felt that their

Table 2.—DUTIES OF RECENT GRADUATES

Principal Duty Function	Per cent
Sales	22
Research	21
Management and Supervision	16
Engineering	11
Quality Control and Inspection	5
Promotion and Development	5
Instruction, Production, and Forestry	13

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college education was sufficient to handle their starting job, and that their training could be directly applied to this job. Opinion was split evenly as regards the desirability of a range of choice in specialization within the forest products or wood technology fields. In this connection, two-thirds favored specialization through a relatively free election of courses with a minimum of absolute requirements. Seventy per cent stated that work experience, as part of their technical training, should be compulsory.

A list of 44 courses commonly offered in college curricula was rated to indicate: a) courses you need more of; b) courses in proper balance to your needs; c) courses you need less of; and d) courses taken, but which you could have omitted. The opinions expressed are too voluminous for presentation in tabular form, but they can be summarized as follows:

1. Forty per cent or more wanted more: technical (report) writing, speech, law, finishing, machining, adhesives, forest products, field trips, construction, mechanical engineering, cost control, statistics, administration, marketing, plant and office management, business, finance, and taxation.
2. Additional courses most often suggested as desirable included: engineering, technical forest products, and business.
3. Leading the field of courses which could have been omitted from college degree requirements were: history, political science, psychology, languages, forest management, silviculture, and logging.
4. Courses which could have had less attention include all of those which could have been omitted plus pathology, botany, social science, and retailing.
5. Forty per cent or more expressed satisfaction in 39 of the 44 courses listed; the remaining five courses were all in the area of business.

A study of current curricula in wood technology and related fields indicates a definite recognition of implied shortcomings listed in this survey through the incorporation of more courses of the types desired. A wide variety of specialized curricula are available, many of which allow substantial choice in technical programs.

The breadth of the forest products-utilization-wood technology field seems to be so great that no basic core of minimum requirements has been agreed upon among the colleges offering training in these areas. Many of the men answering this questionnaire suggested an even more restricted scope of free electives with primary emphasis on basic sciences such as mathematics, physics, chemistry, engineering, and industrial engineering.

Perhaps some idea of the overall opinion expressed can be obtained from answers to the question: "If you were starting college again, what curriculum would you take?" Forty-two per cent would choose the same as taken; 10 per cent would take a different forest products curriculum; 22 per cent would switch to engineering; and 4 to 5 per cent, each, would take forest management, business, pure science, medicine, and miscellaneous.

Experience in Obtaining Employment

In answer to the question, "How was your first job obtained?", 64 per cent stated they were placed through their own efforts and 31 per cent were placed by the schools. Employment agencies and advertisements were effective in placing only 4 per cent of these men. Eighty-four per cent reported that more than one job was open to them and that their first job was chosen for the following reasons: opportunity and potential advancement 50 per cent; experience 21 per cent; prior association 17 per cent; and pay scale 8 per cent.

On the average, graduates had held three jobs prior to current employment. These job experiences were of many types, primarily summer work in forest products and related industries. Starting salaries varied widely in any particular year, but show an increasing upward trend, as indicated in Table 3.

Currently, the prospects are that college graduates can look forward to starting salaries in the range of $4800 to $5000 per year, based on recent inquiries from industry to colleges.

A separate section of the questionnaire devoted to professional development brought out some interesting facts. Only one-third of the 192 men responding are members of FPRS, despite the fact that 80 per cent belong to other professional and business organizations. One-fourth think that licensing would be beneficial and 60 per cent believe minimum standards should be established for professional status.

No agreement was apparent on a name for college graduates in the wood technology–utilization–forest products field; most commonly suggested were the names of forest products engineer, wood technologist, and wood engineer. It seems evident that a large share of the men questioned feel that their duties and place in the forest products industries are related to the functions of professional engineers.

Table 3.—AVERAGE STARTING SALARY IN FIRST PROFESSIONAL JOB[1]

1946	$2906	1952	$3825
1947	3309	1953	4020
1948	2997	1954	4200
1949	2974	1955	4484
1950	3251	1956	4320
1951	3596		

[1]Average of 7 to 38 replies except 1956—3 replies.

Summary

1. A high percentage of returns were from men who had earned advanced degrees—43 per cent. This is probably unrepresentative of graduates as a whole but reflects the increasing tendency for men to take advanced graduate work. Some of the advanced degrees were in areas other than wood technology; an additional 5 per cent had taken advanced work not leading to a degree.

2. An increasing number of men are finding employment in the research and engineering aspects of wood industries with fewer going into actual production jobs.

3. The low level of on-the-job training reported indicates a lack of recognition on the part of many employers of the necessity of training and indoctrination for the recent graduate. Small firms may be unable to give adequate programs, but they can call on local schools, associations, and similar groups for assistance in many instances. This phase of a technical man's education should not be ignored and can go far in supplementing a college "technical" knowledge with an industrial "practical" knowledge.

4. College courses reported as needed reflect the status of employment. Noteworthy in this connection are speech, report writing, newer areas of wood technology, industrial engineering, and business administration. A similar comment applies to suggested additional courses which should be included in college curricula as well as to choice of study if starting college again.

5. Although the majority stated they were satisfied with their jobs, nearly 40 per cent would have chosen a different field if starting college again. This is not an outstanding recommendation for the college curricula taken; however, many revisions and new curricula are currently being offered.

6. It seems unlikely that any single curriculum will be fully satisfactory across the board. Hence, the graduate will not be entirely suited to his starting job. A wide selection of course offerings is not necessarily the answer to this problem—more likely the curriculum offering a basic set of requirements will better educate the man and

give him a training more generally applicable to a wide variety of employment. Specialization can often be best accomplished through additional study.

7. Older graduates are not as critical of their college curricula as are the more recent graduates. This is in further substantiation of the value, in the long run, of substantially basic curriculum requirements.

8. The current shortage of technical graduates and low college enrollment in wood technology fields, despite good beginning salaries, points to an increasing demand for and competition for men. No increase in undergraduate enrollment is foreseen unless the combined efforts of industry and education are put to the task of interesting young men in professional college programs and potential employment.

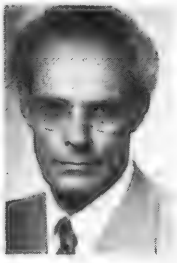
9. The colleges are receiving increasing requests for men and very likely will continue to act as placement agencies between employers and graduates. FPRS, through its summer job and regular placement service, is assisting materially in this effort.

10. Judging from the returns of this questionnaire, a college graduate seems more interested in the opportunity and potential advancement offered by a job than he is in the pay scale. Salaries have been rapidly increasing, however, for a number of years.

11. The incorporation of work experience, either as part of a college requirement or desired by the employer, will require a high degree of cooperation between industry and colleges. Steps in this direction have been taken but should be accelerated.

12. There seems to be no fully acceptable professional status or organization for graduates in wood technology, forest products, and utilization. This challenge should be accepted by the forest products industries and by FPRS in particular.

Experimental Investigation of Gluing and Finishing Problems through Application of Fluorescence Microscopy in Incident Light



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Existing methods of preparation of samples of glued wood and surface films for microscopic observation in transmitted light on slides are unsatisfactory. A procedure is described for visual observation or photography by incident light fluorescence microscopy, adequate for application to gluing and finishing problems. The practical application of the technique is demonstrated with photomicrographs.

Introduction

THE OBJECT OF THIS INVESTIGATION was to develop a simple microscopic technique for the observation and photography of glued wood joints and surface films of finishing materials.

Existing methods of preparation of slides by conventional histological microtome techniques for observation in transmitted light are in many ways unsatisfactory. The chief objections are that the method is cumbersome, time-consuming, and last but not least, does not exclude the possibility of the formation of artefacts as a consequence of the action of chemicals or solvents on the samples.

Contrasts between the wood substance and the adhesive or between the wood and the surface film of lacquer or paint are frequently not sufficiently striking in stained thin sections to permit statistical evaluation of the characteristics of the samples in question. Moreover, there is a need for the observation of long continuous glue lines or surface films, not readily obtainable in ordinary microtome sections.

In order to avoid these inadequacies, a simple procedure has been developed for making preparations of glue lines or surface films in wood for visual observation or photography by incident light fluorescence microscopy.

The method consists essentially in staining the adhesive or finishing material before application, staining the wood portion after gluing or finishing, and preparing the specimens for observation by incident ultraviolet light, through smoothing small blocks with a microtome. Fluorescent colors are used as stains, giving marked contrasts between wood and adhesive or wood and surface film. The color solutions are used in high dilution and their inertness towards the processes under investigation has been tested in blind runs.

Fluorescence and Its Application to Microscopy

Fluorescent light, like other kinds of light, is a form of energy. Specifically fluorescence is produced through inciting light; thus fluorescence is transformation of light energy into another form of light energy. Fluorescence is shown only as long as the inciting light is on. If a substance able to show fluorscence is exposed to light, part of the light is absorbed and part reflected. The absorbed portion again is partly transformed into heat and partly starts such reactions in the material that fluorescent light is emitted. The ability of a chemical substance to show fluorescence is a function of its chemical constitution.[2] Some substances such as chlorophyll, certain protoplasm, some natural dyes, have

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[2] At present Laboratorium M. Himmelheber Baiersbronn, Germany.

[2] See f. i. Theodor Forster, Fluorescenz Organ. Verbindungen. Gottingen, 1951.

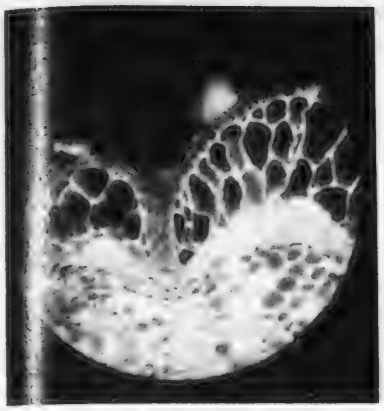

Fig. 1.—Self-fluorescence of wood. Cross-section of the bark of a young sprout of Silver fir (Abies alba). UV-transmitting filter Leitz UG-2. Objective Ultropak UO 22x. Ocular 8x. Ilford H5 sheet film. Exposure time 40 minutes.

the ability to show fluorescence (Fig. 1). Materials lacking this capacity can be induced to fluoresce by staining them with fluorescent solutions of certain dyestuffs, which are selectively adsorbed by the material in question. This is called secondary fluorescence (Fig. 2). Fluorescence also depends on the wavelength of the inciting light; only the ultra-violet portion of the spectrum gives the high intensity necessary for photography or visual observation.

The technique described on the following pages uses dye solutions for the preparation of wood, adhesives, or finishing materials and ultra-violet incident light for observation and photography.

The principles of modern fluorescence microscopy and its application in histology and chemistry are given by Haitinger (1)[3]. Eichler (2) has applied this method in wood research. Marts (3)[4] has showed its application in study and photomicrography of woody tissues. Schulze and Gothel (4) have used fluorescence in the study of papermaking fibers.

Apparatus

Principles: As a source of light, to incite fluorescence, UV–light is used as it contains only a minor portion of visible rays. The visible portion must be filtered off by an UV-transmitting filter, otherwise the visible portion will be superimposed on the fluorescent light. The UV–transmitting filter does not absorb the red portion of the spectrum. This is accomplished by a special filter designed to absorb the red rays.

Finally, not all the UV-light is absorbed by the specimen and transformed into fluorescent light. This untransformed UV-light may not reach the observer's eye or the photoplate. These undersirable UV-rays are eliminated by the interposition of an UV-absorbing filter in the ocular of the microscope.

Equipment (Fig. 3)[5]: *Light-source* —Luminescence-carbon-arc-lamp (Luminiszenz-Bogenlampe). UV-transmitting filter BG–4. Red rays absorbing solution of copper sulfate (10 per cent).

Miscroscope—Research microscope Ortholux. Ultropak illuminator. Ultropak objective with ring condenser UO–6, 5x and UO 22x (quartz ring condenser). UV-absorbing filter 2 for visual observation and 2.5 for photographing.

Cameras — Aristophot stand with folding camera. Leica camera with a micro reflex addition.

Method

Preparation of Specimens: For the preparation of specimens, the method of Marts (3) with some modifications has been followed.

The fluorescent stain is added to the adhesive (surface finishing material) before gluing (finishing). When the glue has set, the material is cut into appropriate pieces and the wood is softened by submersion in tap water. The softened blocks are then smoothly cut on one side with a sliding type microtome. After surfacing, the staining is performed by immersion into a dye solution. (In preliminary runs drying of the wood specimens has been tried without any marked advantages.)

After elimination of any surplus stain in running tap water, the blocks are placed in a suction flask, filled with tap water and evacuated. The air is evacuated from the wood and the suction continued until the blocks sink to the bottom of the flask and are thoroughly soaked in water.

The blocks are kept under water until the final preparation of the specimens. In this procedure, a piece of material is placed in a small glass dish, ordinary tap water is poured out until the surface of the water stands at the level of the test piece, and a cover glass is placed over the surface in such a way that a very thin water film is developed between the test piece and the cover glass.

Technique of Staining: *Experiments*—A series of preliminary staining trial runs was followed by visual observation with objective UO 22x and ocular 8x.

In the first series four different dyes were tested in the following concentrations:

1. Congo red: a. 1.100; b. 1:1000; c. 1:10000.

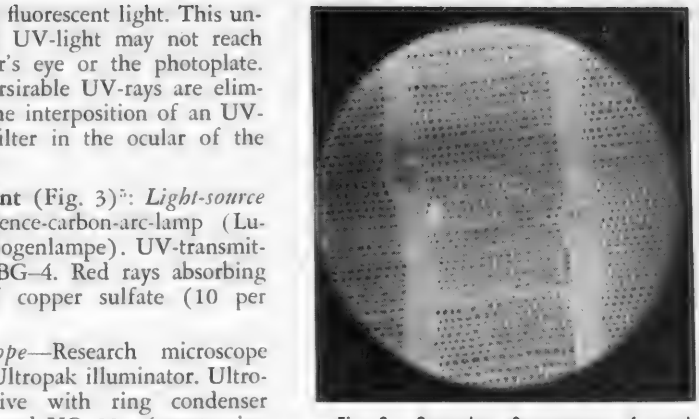

Fig. 2.—Secondary fluorescence of wood. Scots pine (Pinus sylvestris) stained with Rhodamin 3 GD 1:100. UV-transmitting filter Leitz BG-4. Objective Ultropak UO-6, 5x. Ocular 6x. Kodak sheet film P 1200. Exposure time 2 minutes.

[5] The complete equipment from E. Leitz, Wetzlar, Germany.

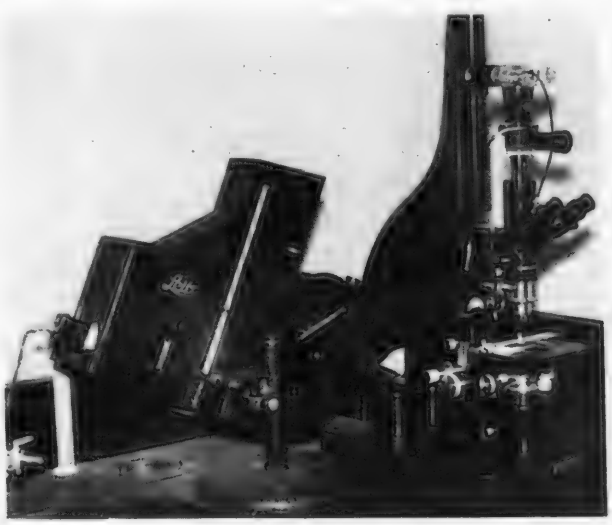

Fig. 3.—Equipment for the fluorescence microscopy in incident ultra-violet light.

[3] Numbers in parentheses refer to literature cited.

[4] The authors are indebted to Mr. Marts for suggestions in connection with the experimental work in this paper.

2. Rhodamin 3 GD: a 1:100; b. 1:1000; c. 1:10000.
3. Corriphosphin: a. 1:1000; b. 1:10000; c. 1:100000.
4. Pryanin: a. 1:100; b. 1:1000.

Blocks of Scots pine (*Pinus sylvestris*) were stained for 30 minutes, then washed under running water for about 15 minutes, and finally evacuated and soaked in water for 24 hours.

Rhodamin 3 GD gave the strongest fluorescence in the concentration 1:100, the fluorescence diminishing with decreasing concentrations. At low concentrations, the denser summerwood is not stained.

Contrary to the finding of Marts, Congo red proved unsuitable in all the tested concentrations, probably depending on light source or the filters used. Corriphosphin gave a faint fluorescence, and Pryanin gave only fluorescence in the cell cavities but not in the cells walls.

As Rhodamin gave the best results, it was used in a second series to determine the best staining and water storage period. A solution of the concentration 1:100 was used with the following staining periods: A. 5 min.; B. 10 min.; C. 20 min.; D. 30 min.; E. 60 min.

All test pieces were washed 15 minutes in running water. Some of the specimens were taken for microscopic observation immediately after evacuation of the air. A, B and C were satisfactorily stained in the springwood but not in the summerwood. D and E were relatively good but not yet entirely satisfactory. When the test pieces were stored in water for 24 hours, however, staining was satisfactory in all cases. The best contrast resulted from method E (60 min. staining).

After the best procedure for staining the wood had been established, trials were run to test the best way of dyeing the adhesive resin dispersion. Only a straight urea-formaldehyde resin was tested. The dyes chosen were Pryanin and Corriphosphin. Both of them gave good contrasts to the Rhodamin-stained wood (Pryanin a blue, Corriphosphin a green, and the wood an orange color).

Since then, different wood species and various glues have been used in investigations and details will be found in successive publications.

In certain cases a slight modification of standard procedures has been necessary in order to adapt the method to varying conditions and to obtain optimum results.

Standard Method: The adhesive resin dispersion is dyed with a Pryanin solution 1:100. The dye solution is made up together with the hardener and is used in an amount of 10 per cent on the resin dispersion ready for use. The wood is stained with Rhodamin 3 GD solution 1:100. Staining is done by submersion of the test pieces in the dye solution for 1 hour, followed by a washing for 15 minutes in running tap water and evacuating of the air. The test pieces are then stored in water for 24 hours before preparation of the specimens for observation in incident light.

Photography: *Black and white*—The contrasting colors of the red or orange wood and the blue glue line require a panchromatic film. The use of a yellow filter is advantageous for maximum contrasts. Best prints were obtained by using extra hard photographic paper. All photomicrographs in this paper were taken with these materials and in accordance with the standard procedure.

Color—For photographs in color a yellow filter always has to be used. Good reproductions of the colors were obtained with Agfa daylight film. With the objective Ultropak UO-6 5x, the required exposure time was 12 minutes; with objective Ultropak 22x, exposure time was 24 minutes.

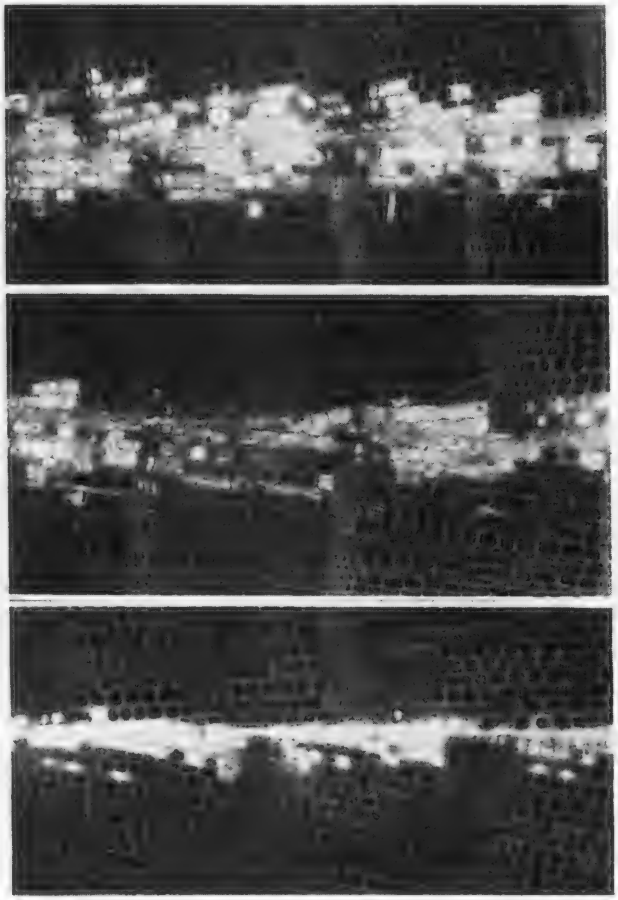

Fig. 4.—Various degrees of penetration of adhesive into wood. Adhesive: urea resin adhesive dyed with Pryanin 1:100. Wood: Scots pine (Pinus sylvestris) stained with Rhodamin 3 GD 1:100. UV-transmitting filter Leitz BG-4. Objective Ultropak UO-6, 5x. Ocular 6x. Kodak sheet film P 1200. Exposure time 2 minutes.

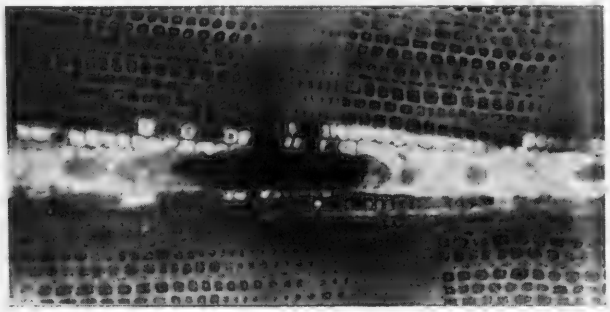

Fig. 5.—Thick external glue line with an air blister. Adhesive: Urea resin adhesive dyed with Pryanin 1:100. Wood: Scots pine (Pinus sylvestris) stained with Rhodamin 3 GD 1:100. UV-transmitting filter Leitz BG-4. Objective Ultropak UO-6, 5x. Ocular 6x. Kodak sheet film P 1200. Exposure time 2 minutes.

Fig. 6.—Lacquer on wood. Lacquer: Water-soluble urea resin lacquer dyed with Pryanin 1:100. Wood: Scots pine (Pinus sylvestris) stained with Rhodamin 3 GD 1:100. UV-transmitting filter Leitz BG-4. Objective Ultropak UO-6, 5x. Ocular 6x. Kodak sheet film P 1200. Exposure time 2 minutes.

No doubt with other materials and circumstances, equally satisfactory results can be obtained under appropriate conditions.

Application to Gluing and Finishing Problems

The above described simple method of the microscopic observation and photography of glue line or surface film characteristics has proved to be a valuable tool in research, production, and service problems.

Especially it has been useful in studying penetration, surface properties, and other factors of the processes under observation. It has made possible the statistical evaluation of glue line and surface film characteristics and has been used extensively in this laboratory since its development.

Results of these investigations are in the process of preparation and will soon be published. Some photomicrographs have been given by Marian (5) and the photomicrographs shown in Figs. 4–6 are only a random selection out of extensive material collected in the course of the investigations.

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Microscopical Rating of Decay in Sitka Spruce and Its Relation to Toughness

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Report of a study to determine whether reduction in toughness caused by wood-rotting fungi might be estimated in relation to microscopical changes in the wood. Although limited to Sitka spruce, the information gained from the study should indicate the value of this indirect method of estimating toughness losses and its application to other woods and to additional decay fungi.

Introduction

THE EFFECT OF DECAY on the physical characteristics of wood has been studied at various times, particularly of wood to be used in aircraft construction (3)[1], in ladders, or in plywood (1). In one of these studies (3), it was noted that the strength of wood could be correlated to some extent with the visible progression of decay. In wood of Sitka spruce (*Picea sitchensis* (Bong.) Carr.), there was a slight reduction in toughness beyond the zone of typical rot caused by the white-rot fungus *Fomes pini* (Thore) Lloyd; but there was a marked reduction in toughness—up to 20 per cent—at the outermost limits of incipient rot caused by the brown-rot fungus *Polyporus schweinitzii* Fr.

This and similar studies indicated the possibility of evaluating strength of wood in the early stages of decay through changes in microscopical character. Reliable appraisals of strength by microscopical observations would be useful not only for diagnosing wood discolorations, but also for recognizing wood that should be rejected for specific uses, or wood that might be safely used, thus preventing unnecessary waste of high-grade material.

The study reported here was undertaken to determine what correlation might exist between the toughness of Sitka spruce wood attacked in different degrees by certain decay fungi and the microscopical factors of the wood that could be rated quantitatively. Insofar as known, there is no published account of previous attempts to index the progress of decay by means of microscopical criteria.

Microscopical Rating of Decay

Preparation of Material

As an aid in establishing a standard method for obtaining a numerical decay rating that would represent the stages of incipient decay, pure cultures of seven species of wood-rotting fungi were grown on sterilized Sitka spruce blocks. Isolates of these species were cultured from 19 flitches of Sitka spruce that were selected at three sawmills in Oregon and Washington. The cultures were made[2] from samples of wood selected at 6-inch intervals lengthwise and 1-inch intervals crosswise of one board of each flitch. The isolates and the designations by which they were identified in this study are as follows:

Brown-rot fungi: *Poria monticola* Murr., OB14, MLB19; *Polyporus schweinitzii,* OB3, MLB8, OB11, MLB18, MLB22, MLB24; *Polyporus sulphureus* Bull. ex Fr., MO32, MO39, MO43, MO44; *Lentinus kauffmanii* Smith, MLB7, MLB10, MO35.

White-rot fungi: *Fomes pini,* OB30, OB31; *Poria subacida* (Pk.) Sacc., OB15; *Polyporus borealis* Fr., MO38.

Logs infected with *Trametes serialis* Fr., which causes brown rot, could not be obtained from the mills. Because of the similarity of this rot to that caused by *Poria monticola,* four isolates of *T. serialis* and two additional isolates of *P. monticola* were included in the culture study. These isolates were obtained from the culture collection of wood-rotting fungi maintained by the former Division of Forest Pathology, U.S. Department of Agriculture, at Beltsville, Md., and Madison, Wis., and are designated as follows: *P. monticola,* Madison ♯698 and ♯575; *T. serialis,* FP66267, FP66269, FP94023, and F9520.

To prepare specimens of decayed wood, pure cultures of the various isolates were grown on malt agar in 6-ounce wide-mouth bottles (resting on

[1] Numbers in parentheses refer to literature cited.

[2] Cultures were made and the fungi identified by R. W. Davidson, Division of Forest Disease Research, Rocky Mountain Forest Experiment Station, Forest Service, U. S. Department of Agriculture. The letters used with the culture numbers indicate the different sources of the flitches.

The Authors: Dr. A. M. Waterman is forest pathologist, stationed at the Forest Insect and Disease Laboratory, Northeastern Forest Experiment Station, New Haven, Conn. She holds A. B., M. A. and Ph. D. degrees from Brown University, has specialized in fungus diseases of trees since 1916.

Dr. J. R. Hansbrough is Chief, Division of Forest Disease Research, Forest Service, Washington, D. C. He received Ph.B. and M. A. degrees from Brown University, Ph.D. from Yale University. He has been in government service since 1926, principally concerned with research to determine cause and control of diseases of forest stands and prevention and protection of wood in service from decay losses.

their sides) until a mycelial mat was formed. Sterilized Sitka spruce feeder blocks (3 x ¾ x ⅛ inches) were then placed upon the mycelial mats. When the feeder blocks were penetrated with mycelium, four sterilized ½-inch Sitka spruce cubes were placed on each feeder block. The cubes had been oven-dried and weighed before they were sterilized.

The cultures were incubated at 26–28° C. Four blocks of each of the isolates of *P. monticola* and *T. serialis*, and two blocks each of the other isolates, were removed at the end of two weeks. They were cleaned of surface mycelium, weighed, oven-dried at 105° C. for 48 hours, then reweighed to obtain weight loss. The remaining blocks of all isolates were removed at intervals of two or four weeks and similarly treated.

Radial sections were cut through the center of selected blocks, and were stained with Pianeze IIIb (4), using a revised formula and technique (5). All sections were examined to determine what characteristics of the interior mycelial growth and what effect of the fungi on the wood might be used for a numerical classification of the decay. The microscopical examination of the radial sections from individual blocks showed that, in each group of blocks infected by an isolate during a definite time period, the decay ratings from sections from one block differed little from sections from other blocks in the same group. Therefore, from each time period for each isolate, only one block was selected for sectioning.

Microscopical Observations of Brown Rots

In incipient decay caused by brown-rot fungi, hyphae were produced in slight or moderate amounts, advancing longitudinally through the tracheids, sometimes in strands but usually by individual branching filaments. The hyphae of rapidly growing isolates, such as those of *P. monticola*, formed conspicuous bore holes during the first two weeks of culture. The hyphae of other species usually passed from one tracheid to another through the bordered pits during the early weeks of culture, but later produced bore holes. The characteristics of the hyphae and the progressive development of decay by the brown-rot fungi are indicated in Table 1. To emphasize the slight distinctions between *P. monticola* and *T. serialis* in incipient decay, these species are described separately from the other brown-rot fungi.

The amount of hyphae in a tracheid had no relation to the amount of visible effect on the tracheid wall. One single hyphal filament produced branches that advanced readily through bore holes in the walls of several tracheids. In contrast, masses of hyphae in other tracheids showed no visible effect on the walls.

Decomposition of tracheid walls other than the formation of bore holes was difficult to detect microscopically in the early stages of decay by the brown-rot fungi. After eight weeks in culture, blocks infected by some of the isolates became checked and slightly shrunken on the tangential faces when oven-dried. In radial sections through these blocks, large coalescing bore holes and slight separation of adjacent tracheid walls indicated decomposition. In cross sections, the effect on the cell walls was more evident. Many of

Table 1.—CHARACTERISTICS OF HYPHAE OF BROWN-ROT AND WHITE-ROT FUNGI AND THE EFFECT ON SITKA SPRUCE WOOD, AS OBSERVED IN MICROTOME SECTIONS FROM BLOCKS INFECTED IN PURE CULTURE DURING DEFINITE TIME PERIODS

Fungi	Culture period Weeks	Characteristics of hyphae	Penetration of cell walls	Other characteristics
BROWN ROTS:				
Poria monticola *Trametes serialis*	4	Fine hyaline, sometimes in strands, usually as single branched filaments. Moderate in amount. Simple and medallion clamps.	*P. monticola*: hyphae usually penetrating through small or large bore holes. *T. serialis*: hyphae usually passing through bordered pits; bore holes small, rare to moderate.	Hyphae and bore holes rarely present in summer wood or in medullary ray cells. Chlamydospores rare.
	8	Abundant; fine hyaline; wide hyaline occasional.	*P. monticola*: bore holes abundant, small or large. *T. serialis*: bore holes small, in moderate amount.	Hyphae and bore holes occasional in summer wood and medullary rays. Chlamydospores abundant.
	12	Less abundant or absent in tracheids with abundant bore holes.	Bore holes very abundant, small or large, coalescing.	Cracks across radial walls of tracheids; slight separation of tracheid walls. Chlamydospores abundant.
Polyporus schweinitzii *Polyporus sulphureus* *Lentinus kauffmanii*	4	Fine hyaline, single filaments sparingly branched; sometimes in strands. Clamps *L. kauffmanii* only, simple.	Bore holes very small, rare to moderate, hyphae usually passing through bordered pits.	Hyphae and bore holes not in summer wood, occasional in medullary rays. Chlamydospores very rare in *P. schweinitzii*, absent in *P. sulphureus* and *L. kauffmanii*.
	8	Fine hyaline in moderate amount; wide hyaline, swollen and irregular in *P. sulphureus* and *L. kauffmanii*.	Bore holes small, but more abundant, varying in amount among isolates of a species.	Hyphae and bore holes in summer wood. Chlamydospores as above.
	12	Hyphae as above, but less in amount in tracheids with abundant bore holes.	Bore holes small or large, coalescing, abundant, except in *L. kauffmanii*.	Cracks across radial walls of tracheids; slight separation of tracheid walls, except in *L. kauffmanii*.
	16	Hyphae as above.	Bore holes profuse in scattered areas; slight corrosion of bordered pits, bore holes in borders of pits, except in *L. kauffmanii*.	As above.
WHITE ROTS:				
Fomes pini *Polyporus borealis* *Poria subacida*	4	Fine hyaline and wide hyaline staining red; wide hyaline with warty irregular walls, staining green. All hyphae profusely branched. Clamps rare in *F. pini*; abundant on all hyphae of *P. subacida* and *P. borealis*.	Bore holes very small, rare to moderate; hyphae frequently passing through bordered pits.	
	8	Abundant; fine hyaline staining red, wide hyaline, staining green; profusely branched. Hyphae with wide walls without any apparent cell contents.	Bore holes small, rare or moderate in amount. Borders of pits corroded, sometimes penetrated by hyphae, except in *P. borealis*.	Green-stained decomposition product in tracheids. Hyphae and bore holes in summer wood and medullary rays.
	12	Hyphae as above, increasingly abundant.	Bore holes moderate in amount; borders of pits decomposed, entire pits sometimes destroyed, except in *P. borealis*.	In *F. pini* and *P. subacida* decomposition products more abundant; thinning of remnants in walls of tracheids, evident by reaction of stain; decomposing walls do not stain at all.
	16	Hyphae as above.	Slight increase in number of bore holes and destruction of bordered pits, except in *P. borealis*.	In *F. pini* and *P. subacida* large areas of unstained tracheids indicate decomposition of cell walls; total decomposition of tracheids occasional.

the tracheids separated partially from adjacent cells or fell out in a powdery mass in the process of cutting. No thinning of the lignin in the walls was noticeable. Other isolates produced macroscopical rot during 8 to 16 weeks in culture.

Microscopical Observations of White Rots

In the early stages of decay caused by the white-rot fungi, the hyphae usually passed from one tracheid to another through the bordered pits, without visible effect on the walls of the pits or on the tracheid walls (Table 1). After eight weeks in culture, the progressive decomposition of the cell walls of tracheids and medullary ray cells was indicated by a gradual thinning of the walls, and particularly by the reaction of the Pianeze IIIb stain.

In radial sections, the lignin in the walls of sound wood commonly stained green to purplish green, but decomposing portions of the walls colored a light red or did not stain at all. The borders of the pits normally stained reddish, but during decomposition they did not take the stain. In many sections, entire pits had been destroyed.

In cross sections, the reaction of the stain indicated clearly the progressive effect of the fungi on the tracheid walls. In sound wood, the lignin in the walls stained a vivid reddish purple. In infected tracheids, the gradual thinning of the lignin and the eventual collapse of the tracheids was accompanied by a change in stain reaction, from purple to green to colorless.

Pockets of rot were particularly evident in summerwood, sometimes extending along the medullary rays across the width of the annual ring. The amount of hyphae in the wood cells seemed to have no relation to the amount of decomposition. No shrinking or checking occurred when the blocks were oven-dried.

Numerical Rating of Stages of Decay

In an analysis of the effects of brown-rot and white-rot fungi on Sitka spruce wood, as indicated by microscopical examination, variations in the amount of hyphae and bore holes among the species of fungi and even among the isolates of a species were evident after four weeks of culture. In Fig. 1, the frequency of the distribution of hyphae and bore holes in the microtome sections examined for each isolate of the fungi is expressed as the percentage of 100 microscopical fields having hyphae only or bore holes. In fields with bore holes, hyphae as well as bore holes were frequently present. In some fields, the hyphae apparently disintegrated or disappeared from the bore holes in the process of sectioning. Therefore, in fields with bore holes, no record of the presence of hyphae was made.

The results of this analysis suggested that a more exact numerical rating of decay could be made by determining the percentage of tracheids in a microscopical field having hyphae, bore holes, or apparent decomposition of cell walls. On this basis, the following classes were selected as representative of the progress of decay.

Class 0: no infected cells in the microscopical field. *Class 1:* microscopical field with hyphae only. *Class 2:* bore holes in only one tracheid in a microscopical field. *Class 3:* bore holes in less than 1/3 of the tracheids. *Class 4:* bore holes in 1/3 to 2/3 of the tracheids. *Class 5:* bore holes in 2/3 or more of the tracheids. *Class 6:* slight decomposition of cell walls in the microscopical field. *Class 7:* pronounced decomposition of cell walls. *Class 8:* macroscopical rot that prevented the sectioning of the block.

One hundred low-power fields (16 mm, 12X objective; 15X eyepiece) in a radial section through the center of a block were tallied according to these classes. An average was obtained by multiplying the number of individual fields in a class by the class number and dividing by the total number of fields tallied in the section. Among 10 or 12 sections from each block, no conspicuous variations in fungus attack were evident; therefore, the decay rating from one section selected at random was considered representative of the stage of decay caused by the isolate during the time period.

In the blocks infected by the brown-rot fungi, hyphal penetration of cell walls was, in general, rapid and fairly uniform. Therefore, the production of bore holes progressed similarly during the entire culture period, but the rate of progression varied markedly among the fungi and even among the isolates of the same fungus. However, when the decay ratings obtained for the isolates of a single species for each time

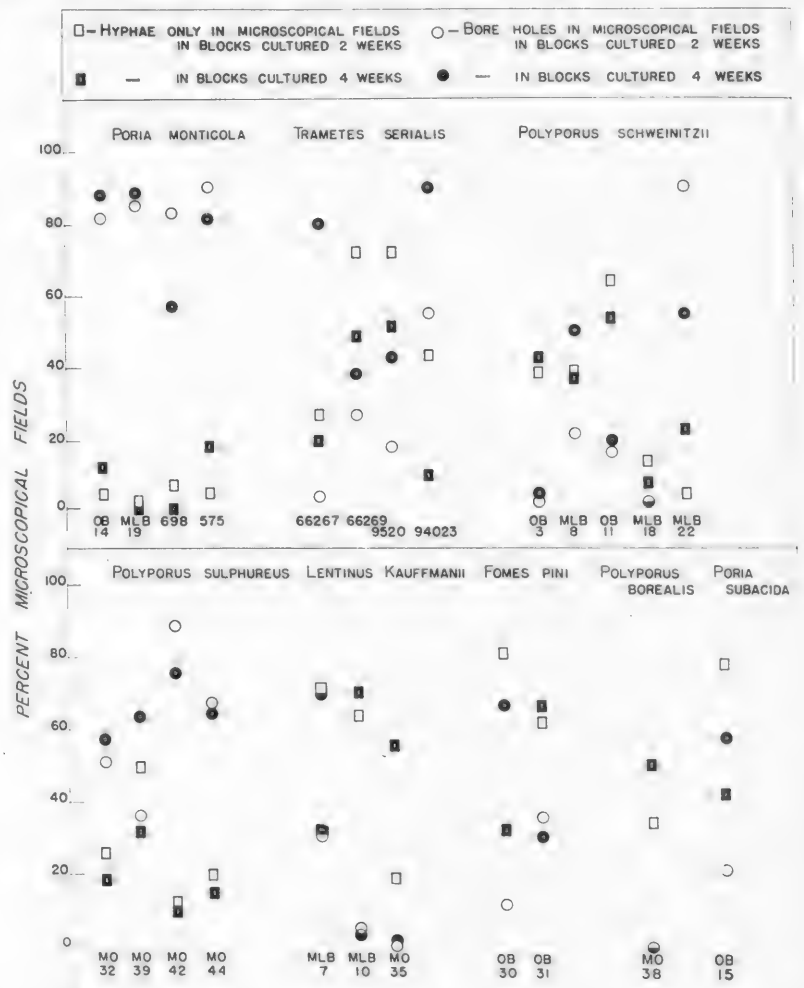

Fig. 1.—Percentage of microscopical fields having hyphae or bore holes in microtome sections from Sitka spruce blocks infected two and four weeks by isolates of five brown-rot fungi and three white-rot fungi.

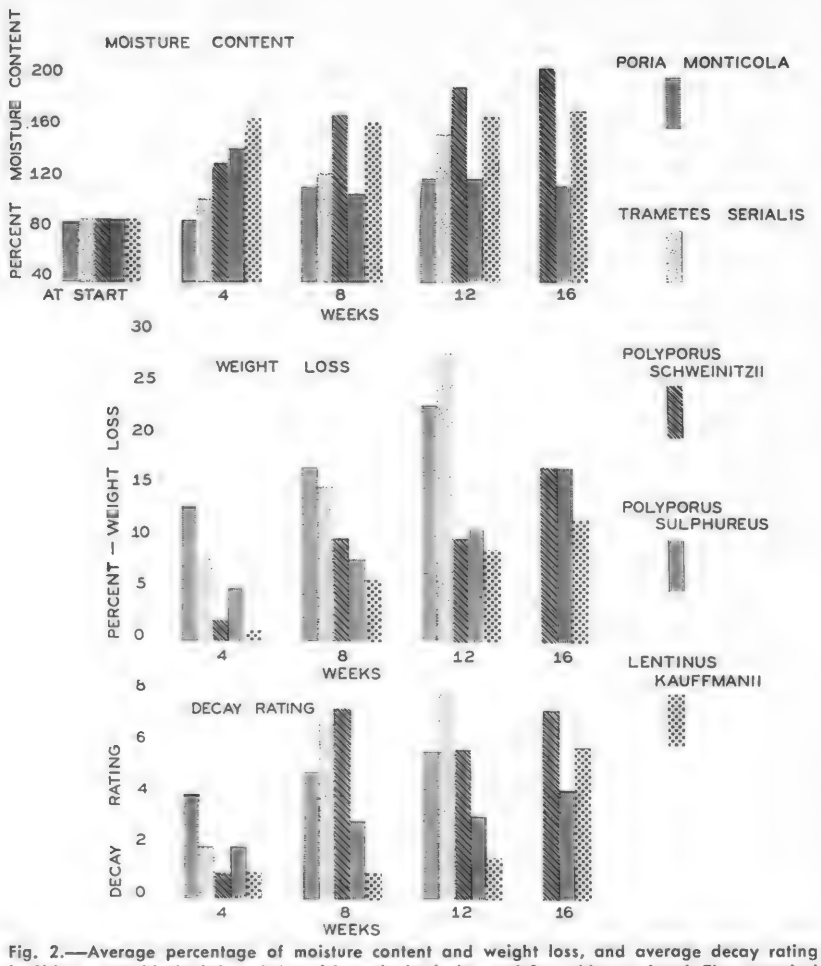

Fig. 2.—Average percentage of moisture content and weight loss, and average decay rating in Sitka spruce blocks infected 4 to 16 weeks by isolates of five white-rot fungi. The numerical basis for the averages is explained in footnote 3.

period were averaged[3], the ratings were found to be closely correlated with the average weight loss for the species (Fig. 2).

In the *P. monticola* blocks, production of bore holes was very rapid, resulting in a high decay rating during the early weeks of culture. Weight loss amounted to 13 per cent in four weeks and 23 per cent in 12 weeks. In the *T. serialis* blocks, the hyphae usually penetrated the bordered pits, and production of bore holes was much less rapid. Weight loss was only 7 per cent in four weeks, but increased rapidly to exceed that for *P. monticola* in 12 weeks. In the early period of culture, these two fungi were quite distinct in their effect upon the wood, but in the later stages the rots were almost indistinguishable.

The decay ratings from the *Polyporus sulphureus* blocks indicated the rapid and uniform progression of mycelial growth and bore hole production. Weight loss showed a slow and fairly even increase throughout the culture period. In the *Polyporus schweinitzii* and *Lentinus kauffmanii* blocks, mycelial penetration was slow and irregular, being more rapid at the top of the blocks than at the base. Relatively few bore holes were produced in the first four weeks, but in general the weight loss during the entire culture period was approximately the same as for *P. sulphureus*.

Among the three white-rot fungi, hyphae developed in considerable abundance, but penetration by bore holes progressed more slowly than in the blocks affected by most of the brown-rot fungi. In the *Fomes pini* blocks, bore holes were formed early but developed only in scattered concentrations. These concentration areas may indicate the early formation of the rot pockets that are typical of advanced decay. The average decay rating was relatively low in the early period of culture (Fig. 3). Decomposition of the tracheid walls and bordered pits, however, occurred throughout the blocks by the end of eight weeks, thus resulting in an increase in decay rating. Weight loss started slowly but increased uniformly to reach 12 per cent in 16 weeks. In the *Poria subacida* blocks, bore hole production was moderate.

Decomposition of tracheid walls and bordered pits was evident in the latter part of the culture period, and decay rating increased regularly. Weight loss increased uniformly during 12 weeks of culture, then decreased slightly. In the *Polyporus borealis* blocks, bore holes were rare, and deterioration of tracheid walls or bordered pits was evident. Weight loss throughout the culture period was negligible.

The number of isolates of the white-rot fungi was small: two for *Fomes pini* and one each for *Poria subacida* and *Polyporus borealis*. It is possible that the reactions observed may not be typical of the species.

Relating Toughness to Decay Rating

Of the 19 flitches of Sitka spruce from which wood-rotting fungi were isolated in culture, only two were selected for a comparison of toughness with decay rating. Both of these, MLB19 and OB14, were infected with *Poria monticola*. The flitches infected with the other fungi were not suitable for a comparison of the strength of infected and sound wood, principally because of poor grain, numerous knots, a limited amount of rot, or indefinite mixed rot caused by more than one fungus.

Method

Flitch MLB19 consisted of three edge-grain boards, 1¼ inches by 10 inches by 12 feet, with decay discoloration extending about 2½ feet from one end. Cultures had been made from samples of wood selected from one of the boards at 6-inch intervals longitudinally, and at 1-inch intervals across the board. *Poria monticola* was isolated throughout the discolored area. After the cultures were made, the boards were kiln-dried seven days.

Only one of the boards was used in the study of toughness and decay rating. It was cut into 1-foot sections; they were lettered consecutively from A to L, extending along the grain from infected into healthy wood. Strips 6 inches long, ⅛ inch wide on the radial face, and the same thickness as the board, were cut from Sections A through G. Each strip was then cut in half longitudinally, making a series of strips from the upper and lower surfaces of the board, each strip being 6 inches long, ⅛ inch on the radial face, and ½ inch on the tangential

[3] The averages for the species were derived from data for the following number of blocks per species: Moisture content at start: *Poria monticola* and *Trametes serialis*, 12 blocks; *Polyporus schweinitzii*, 24; *Polyporus sulphureus*, 16; *Lentinus kauffmanii*, 12; *Fomes pini*, 8; *Poria subacida* and *Polyporus borealis*, 4. Moisture content, weight loss, and decay rating for each time period: *P. monticola*, *T. serialis*, and *P. sulphureus*, 4 blocks; *P. schweinitzii*, 6; *L. kauffmanii*, 3; *F. pini*, 2; *P. subacida* and *P. borealis*, 1.

face (Fig. 4). End-matched strips 2 inches by 1/8 inch by 1/2 inch were cut from each section, from which moisture content and specific gravity based on oven-dried weight were determined. At the time of testing for toughness, the moisture content ranged from 7 to 9 per cent.

The test strips were broken on an intermediate toughness machine (2) with 4-inch span and one-point loading; load was applied on the tangential face. From one portion of each broken strip, radial microtome sections were cut through the 1/2 inch of wood adjacent to the point of break. The sections were stained with Pianeze IIIb, and one section from each set of sections was selected at random for study.

From a microscopical examination under low power, 45 fields covering all of the section were tallied into the decay classes previously described. The average obtained from the microscopical examination of the one microtome section, cut adjacent to the point at which the test strip was broken, was used as the decay rating for the strip.

Flitch OB14 consisted of two edge-grain boards, 3/4 inch by 10 inches by 12 feet, with visible decay discoloration extending about 5 feet from one end. Cultures were made[4] from samples of wood selected at 6-inch intervals longitudinally and at 1-inch intervals across Board 1. *Poria monticola* was isolated throughout the discolored area and beyond it, extending about 5 inches across the board and 10 feet longitudinally.

The boards were air-dried after the cultures were made. A knot occurred in Board 1 a few inches from the end showing decay; so 4 1/2 inches were discarded from this end in both boards. The remainder of the two boards was cut into 1-foot sections; they were lettered B through K. In section C in both boards a knot was present and this section also was discarded.

From the sections to be tested in Board 1, strips were cut 6 inches long, 1/4 inch wide on the radial face, and the same thickness as the board. The strips were then cut in half to make test strips 6 inches long and 1/4 inch on both radial and tangential faces (Fig. 5). The specific gravity and moisture content were obtained from end-matched strips from each section, adjacent to the test strips and measuring 2 inches by 1/4 inch by 1/4 inch. At the time of testing for toughness, the moisture content range was 8 to 10 per cent.

Sections B and D through K from Board 2 were cut into strips 6 inches long, 1/2 inch wide on the radial face, and the same thickness as the board. Each of these strips was then cut into four test strips, 1/8 inch on the tangential face (Fig. 6). Data on moisture content and specific gravity were obtained as in Board 1. The range in moisture content was 8 to 10 per cent at the time of testing for toughness.

The test strips were broken on the toughness testing machine, with 4-inch span and one-point loading. The strips from Board 1 were broken by applying the load on the tangential face, those from Board 2 on the radial face. Microtome sections were cut radially from one portion of the broken strips in sections B, G, I, J, and K of both boards and included the 1/2 inch of wood adjacent to the point of break. They were stained with Pianeze IIIb and examined under the low power of the microscope.

Fifty low-power fields nearest the break in one microtome section selected

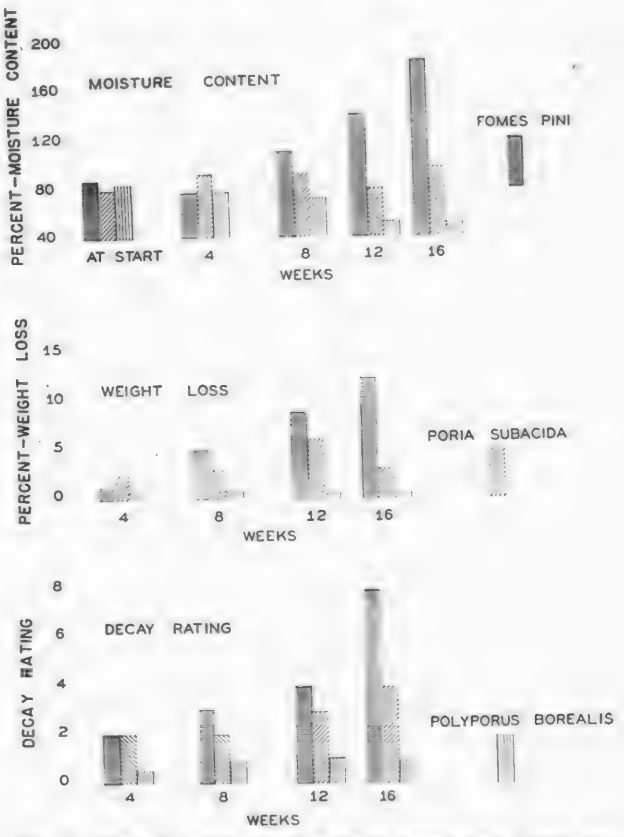

Fig. 3.—Average percentage of moisture content and weight loss, and average decay rating in Sitka spruce blocks infected 4 to 16 weeks by isolates of three white-rot fungi. The numerical basis for the averages is explained in footnote 3.

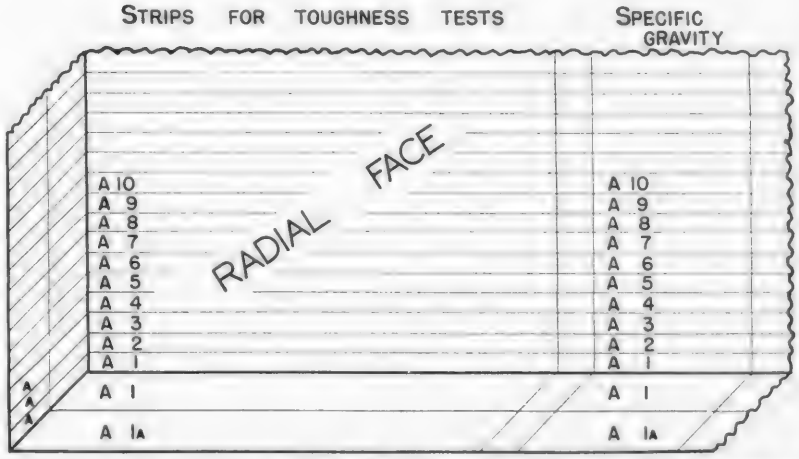

Fig. 4.—Diagram of portion of Section A, Board 2, Sitka spruce flitch MLB19, infected by *Poria monticola*, showing method of cutting strips for toughness tests and for specific gravity. Size of test strip: 6 x 1/8 (radial) x 1/2 inches. Load applied on tangential face of strips.

[4] See footnote 2.

at random were tallied according to the classes used for flitch MLB19. The average obtained for the section was used as the decay rating for the test strip.

Results

The amount of infection in flitch MLB19 (Fig. 7) was so slight that no effect on toughness was evident. Section A, in which discoloration was most noticeable, had an average decay rating of 1.2 and average unit toughness of 8.1 inch-pounds (Table 2). In section G, however, which had no decay, the unit toughness was 7.5 inch pounds.

It is difficult to interpret the variations in the toughness of the test strips. It is recognized that toughness is one of the most variable strength properties of wood. Moreover, it may be that in these thin test strips, the varying amounts of summerwood on the tangential faces resulted in differences in toughness when the load was applied tangentially. Apparently the specific gravity was not involved (Table 2). The data from this flitch indicate that, based on 45 degrees of freedom, the correlation between toughness and decay rating is not significant (Table 4).

Decay was more advanced in flitch OB14 (Table 3, Figs. 8 and 9). The correlation between unit toughness and decay rating in both boards, based on 64 degrees of freedom for Board 1 and 30 for Board 2, was significant at $P = .05$. The data indicate primarily that toughness reductions in Sitka spruce wood infected with *Poria monticola* are not likely to be important if the decay rating does not exceed 2.

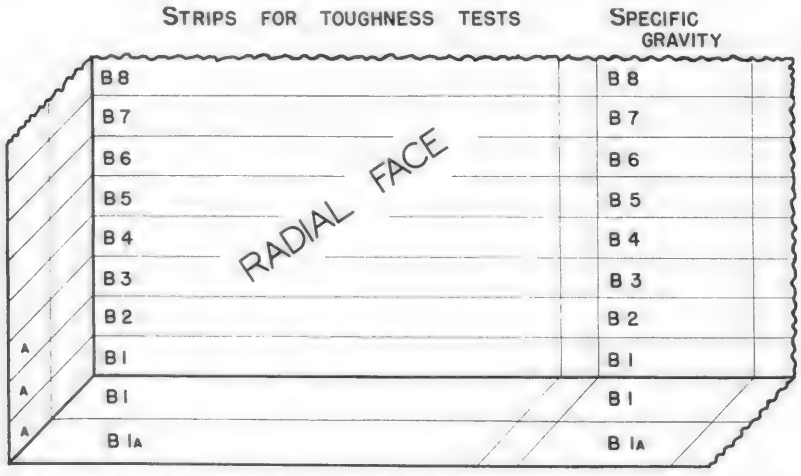

Fig. 5.—Diagram of portion of Section B, Board 1, Sitka spruce flitch OB14, infected by *Poria monticola*, showing method of cutting strips for toughness tests and for specific gravity. Size of test strip: 6 x ¼ x ¼ inches. Load applied on tangential face of strips.

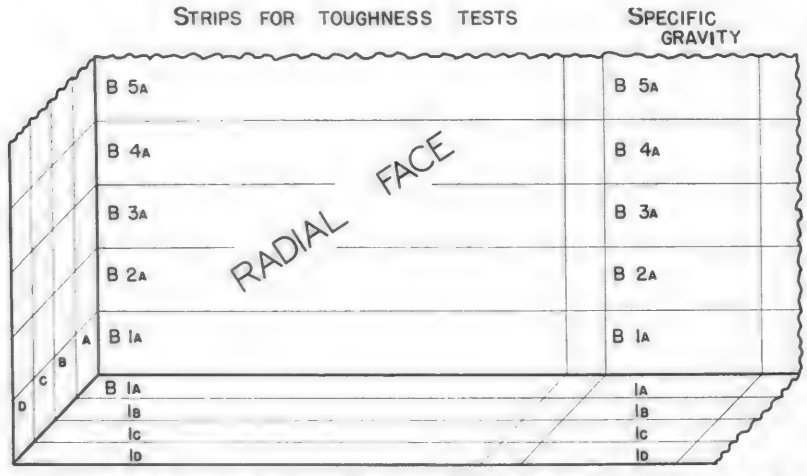

Fig. 6.—Diagram of portion of Section B, Board 2, Sitka spruce flitch OB14, infected by *Poria monticola*, showing method of cutting strips for toughness tests and for specific gravity. Size of test strip: 6 x ½ (radial) x ⅛ inches. Load applied on radial face of strips.

Summary

This study was made to determine whether reduction in toughness caused by wood-rotting fungi might be estimated in relation to microscopical changes in the wood. Although limited to Sitka spruce, the information gained from such study should indicate the value of this indirect method of estimating toughness losses and its application to other woods and to additional decay fungi.

Microscopical features were observed in microtome sections from

Table 2.—SPECIFIC GRAVITY, UNIT TOUGHNESS, AND DECAY RATING OF TEST STRIPS FROM FLITCH MLB19, BOARD 2, INFECTED WITH PORIA MONTICOLA

Load tangential	Section A			Section B			Section C			Section D			Section G		
Test strip number	Specific gravity	Unit toughness in.-lb.	Decay rating	Specific gravity	Unit toughness in.-lb.	Decay rating	Specific gravity	Unit toughness in.-lb.	Decay rating	Specific gravity	Unit toughness in.-lb.	Decay rating	Specific gravity	Unit toughness in.-lb.	Decay rating
1	0.42	7.8	2.2	0.42	9.3	0.5	0.40	7.7	0	0.39	8.4	0	0.42	7.1	
2	.36	5.5	2.3	.36	8.4	1.3	.41	7.0	0	.36	9.0	0	.39	7.2	
3	.36	5.0	2.7	.39	10.1	2.5	.41	10.9	0	.40	6.9	0	.45	8.4	
4	.41	7.8	1.6	.43	11.1	1.8	.43	11.7	0	.38	12.6	0	.39	6.8	
5	.41	6.0	1.8	.43	13.2	1.0	.40	12.6	0	.41	9.8	0	.40	7.9	
6	.39	9.9	0.3	.40	7.9	0.3	.37	9.3	0	.38	10.7	0	.41	6.3	
7	.36	7.5	1.5	.38	10.4	0.8	.38	7.0	0	.36	11.8	0	.39	7.5	
8	.38	4.7	1.7	.38	7.4	0.7	.39	10.8	0	.36	9.2	0	.41	6.9	
9	.38	9.0	1.3	.39	10.5	0.7	.37	10.3	0.1	.39	9.8	0	.39	6.7	
10	.40	8.4	1.2	.41	9.4	0.8	.39	8.0	0.6	.38	6.7	0	.40	7.5	
11	.38	8.5	0.8	.39	7.6	0.5	.39	11.0	0.2	.39	9.4	0	.36	6.0	
12	.41	11.0	1.8	.40	8.8	0.8	.38	7.2	0.7	.40	10.0	0	.38	8.5	
13	.44	10.9	1.2	.45	9.0	0.5	.37	9.5	0.9	.38	11.2	0	.39	8.0	
14	.43	9.3	1.2	.44	10.0	1.9	.42	9.6	0.5	.40	10.7	0	.36	6.6	
15	.41	11.2	0.8	.41	8.7	1.2	.39	8.9	0.1	.43	10.4	0	.35	6.6	
16	.44	9.2	0.6	.43	7.7	0.2	.42	9.8	0	.41	9.2	0	.38	7.1	
17	.46	9.9	0.6	.43	8.9	0.5	.41	12.6	0	.43	10.9	0	.39	10.3	
18	.42	5.8	0.5	.44	10.7	0.6	.43	9.9	0	.43	6.4	0	.38	9.9	
19	.41	6.8	1.2	.42	10.2	0.4	.44	9.1	0	.44	7.6	0	.40	8.2	
20	.42	7.5	0.6	.43	9.2	0.6	.43	8.9	0	.44	11.0	0	.39	6.5	
Average	.40	8.1	1.3	.41	9.4	0.9	.41	9.6		.40	9.6		.39	7.5	

Sitka spruce blocks subjected to decay, in pure cultures, by five brown-rot fungi, *Poria monticola, Trametes serialis, Polyporus schweinitzii, Polyporus sulphureus,* and *Lentinus kauffmanii,* and three white-rot fungi, *Fomes pini, Poria subacida,* and *Polyporus borealis.* All of these had been isolated from Sitka spruce lumber.

The progress of decay caused by the brown-rot fungi was indicated by an increase in the production of bore holes by which the fungi penetrated the tracheid walls, and by a slight separation of the walls of adjacent tracheids. The white-rot fungi produced fewer and smaller bore holes, but decomposition of the lignin in the tracheid walls and the resulting thinning of the walls, particularly noticeable in cross sections, showed the progress of decay. The amount of hyphae visible within the tracheids seemed to have no direct relation to the amount of decomposition in the tracheids.

The presence of hyphae, bore holes, and decomposition of cell walls in the individual tracheids of a microscopical field was used as a basis for establishing a numerical rating of decay. The stages of decay were classified as follows: *Class 0,* no infected cells in the microscopical field; *Class 1,* microscopical field with hyphae only; *Class 2,* bore holes in only one tracheid in a microscopical field; *Class 3,* bore holes in less than 1/3 of the tracheids; *Class 4,* bore holes in 1/3 to 2/3 of the tracheids; *Class 5,* bore holes in 2/3 or more of the tracheids; *Class 6,* slight decomposition of cell walls in the microscopical field; *Class 7,* pro-

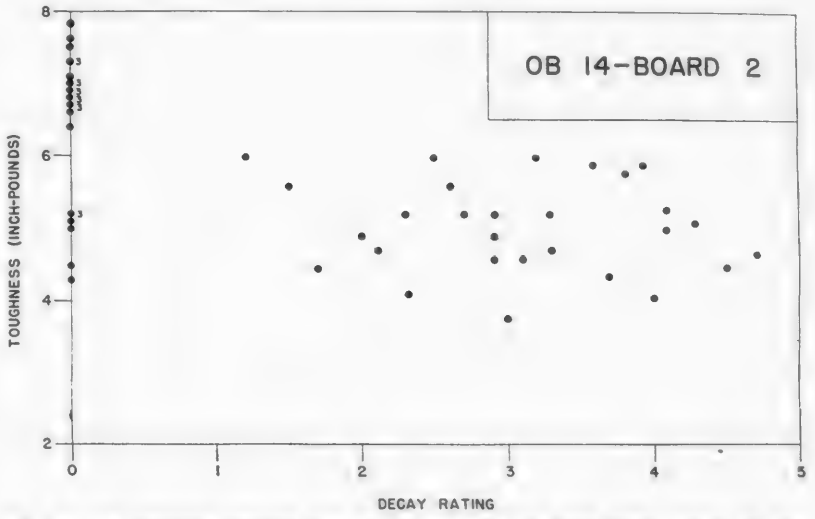

Fig. 9.—Unit toughness compared with decay rating of Sitka spruce wood infected by *Poria monticola.* Unit toughness in inch-pounds derived from test strips of flitch OB14, Board 2, Sections B, G, I, J, K, broken by load applied on radial face. Decay rating from classification of effect of fungus on wood of test strips, obtained from microtome sections cut adjacent to the point of breakage.

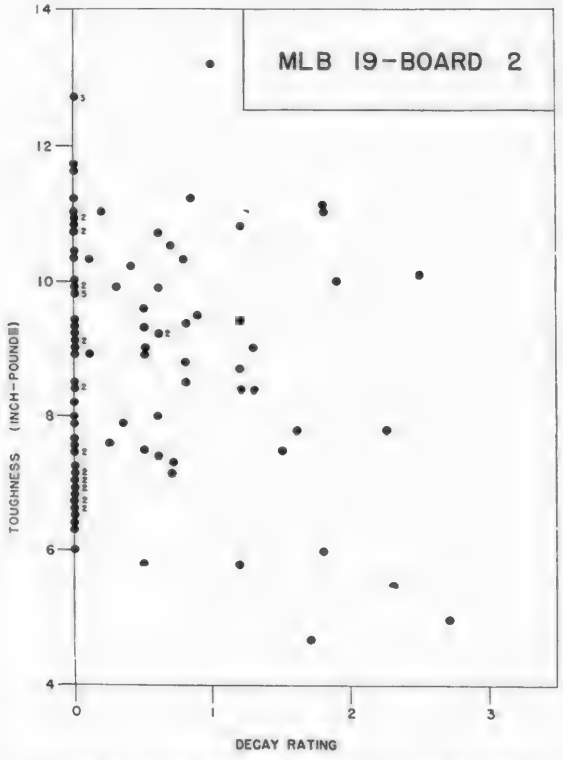

Fig. 7.—Unit toughness compared with decay rating of Sitka spruce wood infected by *Poria monticola.* Unit toughness in inch-pounds derived from test strips of flitch MLB19, Board 2, Sections A, B, C, D, G, broken by load applied on tangential face. Decay rating from classification of effect of fungus on wood of test strips, obtained from microtome sections cut adjacent to the point of breakage.

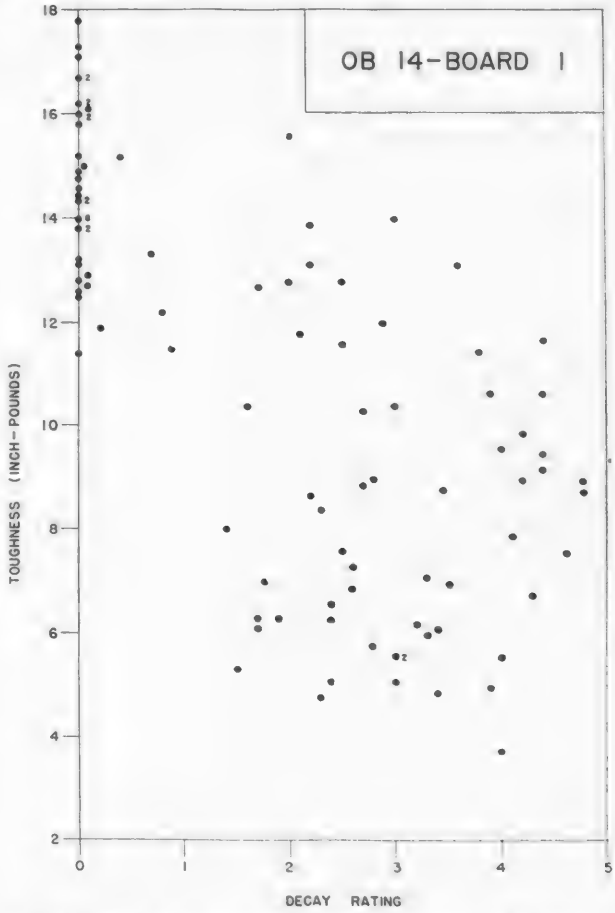

Fig. 8.—Unit toughness compared with decay rating of Sitka spruce wood infected by *Poria monticola.* Unit toughness in inch-pounds derived from test strips of flitch OB14, Board 1, Sections B, G, I, J, K, broken by load applied on tangential face. Decay rating from classification of effect of fungus on wood of the test strips, obtained from microtome sections cut adjacent to the point of breakage.

Table 3.—SPECIFIC GRAVITY, UNIT TOUGHNESS, AND DECAY RATING OF TEST STRIPS FROM FLITCH OB14, BOARDS 1 AND 2, INFECTED WITH PORIA MONTICOLA

Board 1, load tangential	Section B			Section G			Section I			Section J			Section K		
Test strip number	Specific gravity	Unit toughness in.-lb.	Decay rating	Specific gravity	Unit toughness in.-lb.	Decay rating	Specific gravity	Unit toughness in.-lb.	Decay rating	Specific gravity	Unit toughness in.-lb.	Decay rating	Specific gravity	Unit toughness in.-lb.	Decay rating
1	0.44	10.9	3.9	0.45	6.9	2.6	0.49	10.3	2.7	0.51	13.3	0.7	0.49	16.2	0
2	.46	7.6	4.6	.48	4.9	3.4	.43	4.8	2.3	.43	9.0	2.8	.44	8.4	2.3
3	.49	9.0	4.8	.47	5.1	2.4	.41	3.8	4.0	.40	6.2	3.2	.40	7.0	3.5
4	.43	8.8	4.8	.49	5.6	3.0	.45	6.0	3.3	.43	6.1	1.7	.46	15.6	2.0
5	.40	6.8	4.3	.45	6.3	1.9	.43	6.6	2.4	.43	6.3	1.7	.43	12.2	0.8
6	.42	7.9	4.1	.44	5.0	3.9	.42	7.6	2.5	.41	8.0	1.4	.42	12.7	2.2
7	.43	9.0	4.2	.46	5.8	2.8	.42	8.9	2.7	.42	10.4	3.0	.41	15.2	0.4
8	.43	8.8	3.7	.40	6.1	3.4	.39	7.1	3.3	.41	7.0	1.7	.41	10.4	1.6
9	.43	10.7	4.4	.43	7.3	2.6	.43	5.6	3.0	.40	5.3	1.5	.41	11.9	0.2
10	.43	9.2	4.4	.41	5.7	4.0	.40	5.1	3.0	.39	6.3	2.4	.49	11.4	0
11	.40	11.7	4.4	.40	14.0	3.0	.40	8.7	2.2	.41	11.5	0.9	.40	14.0	0
12	.41	9.5	4.4	.39	11.8	2.1	.40	11.6	2.5	.41	12.7	0.1	.40	12.5	0
13	.43	9.9	4.2	.39	12.8	3.1	.42	16.1	0.1	.42	16.0	0	.40	13.8	0
14	.44	11.5	3.8	.39	13.9	2.3	.42	15.0	0.05	.43	14.9	0	.42	14.5	0
15	.42	9.6	4.0	.39	12.8	0.03	.41	16.7	0	.43	16.2	0	.41	15.2	0
16	.43	12.0	2.9	.44	12.9	0.1	.44	14.0	0	.45	14.4	0	.45	16.7	
17	.45	13.1	4.1	.47	14.4	0	.45	17.1	0	.45	13.8	0	.46	14.8	
18	.47	12.8	2.5	.45	16.0	0	.45	17.3	0	.45	17.8	0	.45	14.0	
19	.48	15.8	0	.46	13.1	0	.45	14.6	0	.45	13.2	0	.45	12.6	
Board 2, load radial															
1	.43	4.7	4.7	.47	5.2	2.7	.46	6.0	3.2	.47	5.2	3.3	.47	6.9	
2	.48	5.9	3.9	.51	5.2	2.9	.45	3.8	3.0	.41	4.1	2.3	.49	5.0	
3	.45	5.8	3.8	.46	4.9	2.9	.46	4.9	2.0	.43	4.5	1.7	.44	5.2	
4	.48	6.6	1.5	.42	4.7	3.3	.43	4.6	3.1	.42	4.7	2.1	.43	5.1	
5	.44	5.3	4.1	.42	4.1	4.0	.42	4.6	2.9	.42	5.2	2.3	.41	4.5	
6	.42	4.5	4.5	.40	4.4	3.7	.41	5.6	2.6	.43	5.6	1.5	.41	5.2	
7	.43	5.1	4.3	.42	5.0	4.1	.43	6.0	2.5	.42	6.0	1.2	.40	4.3	
8	.45	5.9	3.6	.43	6.5	0.8	.42	7.0	0	.44	6.4	0	.40	5.2	
9	.46	6.4	2.5	.44	6.7	0	.44	6.7	0	.46	7.1	0	.45	6.8	
10	.46	7.4	0.5	.45	7.0	0	.46	6.8	0	.45	6.9	0	.45	7.3	
11	.46	7.0	0	.47	7.3	0	.46	6.9	0	.46	7.3	0	.47	6.8	
12	.46	7.5	0	.44	6.7	0	.48	7.6	0	.47	6.6	0	.46	7.8	

nounced decomposition of cell walls; *Class 8*, macroscopical rot that prevented the sectioning of the block.

Individual microscopical fields of a microtome section were tallied into these classes. An average was obtained for the section, and this was used as a rating to indicate the amount of decay in the block.

The relation between decay rating and toughness was determined by making parallel ratings of toughness and decay of test strips from two 12-foot Sitka spruce flitches that were naturally infected with *Poria monticola*. This relationship proved to be highly variable. Nevertheless there was a clearly defined association of average values for both factors. It appeared that toughness reductions in Sitka spruce infected by *Poria monticola* are not likely to be serious if the decay rating does not exceed 2. With ratings greater than 2, toughness deficiencies tend to be progressively larger and are a factor to be considered if wood is to be used where strength is important.

Such a microscopical system of decay rating for indexing the toughness of decayed wood obviously will require amplification and refinement before it can be considered for practical use. However, the amount of correlation between rating and toughness observed in this restricted study seems to be sufficient to offer some promise in that direction. More information is needed concerning different combinations of fungi and wood, and the microscopical characteristics that consistently represent the progress of decay caused by all types of wood-rotting fungi. The identity of the causal fungus should not be made a part of any rating system. Also, a strength property that does not have the inherent variability of toughness, such as bending strength or crushing strength, should be considered.

Table 4.—UNIT TOUGHNESS IN UNINFECTED AND INFECTED WOOD OF SITKA SPRUCE, AND CORRELATION OF TOUGHNESS WITH RATING OF DECAY CAUSED BY PORIA MONTICOLA

Flitch and board no.	Uninfected wood: Unit toughness Mean	Uninfected wood: Unit toughness Standard deviation	Infected wood: Unit toughness Mean	Infected wood: Unit toughness Standard deviation	Infected wood: Decay rating Mean	Infected wood: Decay rating Standard deviation	Correlation coefficient	Standard deviation
MLB19-2	8.906	1.923	8.872	1.7	.826	1.308	.239	.1405
OB14-1	15.038	1.453	8.748	1.591	2.695	2.445	.302	.113
OB14-2	6.357	1.744	5.237	1.584	2.894	2.247	.488	.139

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Acceptance Sampling of Veneer Using the Lot-Plot Plan[1]

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and

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The lot-plot plan employs a frequency histogram in an analysis of quality on a lot basis and is based on sampling a variable rather than an attribute. The procedure involved in developing a lot-plot is explained and examples of applications are given for moisture content and thickness of veneer. The results indicate that this relatively simple technique is a valuable management tool that is readily understood.

Introduction

ACCEPTANCE SAMPLING in a quality control program has the initial objective of obtaining facts as a basis for decisions regarding acceptance of lots purchased. The next objective is to convert these facts into corrective manufacturing adjustments in order to improve and to stabilize quality at the desired level. The latter objective is by far the most important of the two, but it is more difficult to accomplish and less often achieved. To achieve these two objectives, a wide variety of industries have used Shainin's (9)[2] lot-plot plan effectively.

The lot-plot employs a frequency histogram in an analysis of quality on a lot basis. Each lot is considered separately and the lot-plot serves as a report to the supplier on his performance. The information provided to the supplier is designed to encourage that producer to manufacture and ship a product that consistently meets requirements specified. In fact, the purchaser may hope that his supplier will be led into the use of statistical quality control methods in his operations, a result that would be of mutual benefit.

Several articles have appeared on the lot-plot (1, 2, 4, 12). These papers give criticisms and show how the original plan has been modified to suit the convenience of many users. This paper is a report on how the lot-plot technique has been found to be suitable for sampling purchased veneer for moisture content and thickness. Jamestown Veneer and Plywood Corp., Jamestown, N. Y., has been using this method of sampling for two years with the desired results.

Lot-Plot Features

At the outset it should be understood that if control charts are used at the point of manufacture and the results submitted to purchasers, there may be no need to use the lot-plot. The purchaser of veneer has no means of determining the order of production for the purpose of controlling quality of veneer sheets. Only the producer has the opportunity to make use of conventional $\bar{X}$ and R charts. If he fails to do this, the lot-plot helps fill the gap and eventually may lead to the use of control charts in manufacturing. Several manufacturers have found the lot-plot more economical to use even in places where control charts could be applied (10).

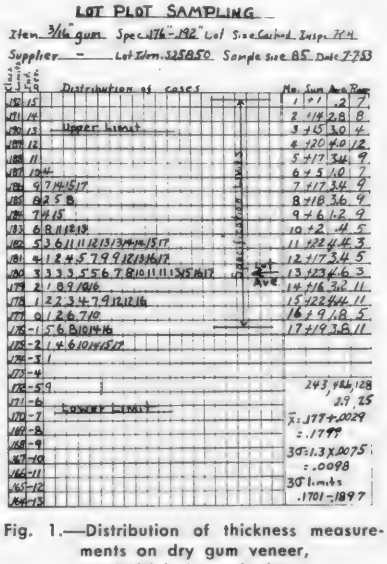

Fig. 1.—Distribution of thickness measurements on dry gum veneer, 3/16-inch nominal.

An excellent feature of the lot-plot is that it is based on sampling a variable rather than an attribute. As a result, far more information is available for acceptance and disposition decisions. Simply to know that the veneer is too wet, or even to know that a certain percentage of sheets is too wet, is not enough. In order to make realistic decisions regarding acceptance, and especially in relation to manufacturing processes, a measure of variability must be given. How much too wet can be known if a frequency distribution based on an adequate sample of moisture content percentages is provided.

Shainin's (9) lot-plot and modifications of it described by Ashley (2) and Wilson (12) make use of a frequency distribution in obtaining an average and three standard deviation limits. The original plan of Shainin calls for a sample of 50 items to be taken from each lot in question. An average is obtained by using coded sums of ten groups of five measurements each which are multiplied by 0.2. The limits of three sigma are estimated by using ranges of the ten subgroups of five. The average range is multiplied by 1.3 to obtain three sigma.

In addition to Shainin's articles (9, 10, 11), several textbooks on industrial statistics give descriptions of the lot-plot (3, 5, 6)

The lot-plot has not escaped criticism. Some plants have found it unsatisfactory in their operations. Reasons for failure are not readily apparent. Perhaps the technique was ill-chosen or misused in some instances. The shortcomings of lot-plot described by Craig (4) should be recognized. The argument that a sample of 50 is

[1] Presented at Session I, Quality Control, FPRS Tenth National Meeting, June 4-7, 1956, in Asheville, N. C.

[2] Numbers in parentheses refer to literature cited.

The Authors: W. C. Hitchings received B. S. degree from State University of New York College of Forestry, Syracuse. He was quality control supervisor and later production manager at Jamestown Veneer and Plywood Corp. before accepting his present position.

A. E. Wylie holds B. S. and M. F. degrees from Colorado A & M College, Ph. D. from the New York College of Forestry. He has experience in survey and appraisal work for public utilities, U. S. Forest Service, and Colorado Experiment Station, was on the Syracuse forestry college faculty before accepting his present position in August 1956.

inadequate can be met by taking larger samples. A completely satisfactory operating characteristic curve has not been developed for the lot-plot. Nevertheless, the lot-plot offers valuable assistance in those cases where, for one reason or another, a better method cannot be employed. The shortcomings are evident at the outset and should be recognized by anyone deciding to use the method.

Although a sample of 50 has been recommended for use in lot-plots, larger samples work well and may be needed. The sample plot in Fig. 1 is based on 85 thickness measurements taken from a rail car of 3/16-inch gum veneer. The figure provides a graphic presentation of the thickness variability as found in the sample. The chart includes sample limits of three standard deviations compared with specifications. A visual comparison can be made between the frequency distribution and a normal curve. This is a simple and relatively efficient method of obtaining information that is vital to control. Much more information is available than could be had from a report giving sample average, high and low measurements.

The step-by-step procedure for making a lot-plot involves minimum difficulties for non-statisticians. Fig. 1 will be used as an example in giving the steps of development beginning with the form containing headings and cross-sectioned area. The usual requirements for sampling are observed. The randomized sample was taken from a railcar of veneer as it was unloaded.

The following steps were involved in making the lot-plot:

1. Place coded thickness on the chart allowing a few spaces beyond specification limits, here 0.176" to 0.192".
2. Take the first five readings and obtain their average.
3. The average, here 0.177", is placed in the column to the left of the zero located in the column of coded thicknesses. Other thickness values are filled in.
4. Record the first five readings in subgroup 1 (One) by placing the numeral 1 in the first open square to the right of the actual thickness. (In this case opposite 0.174", 0.175", 0.177", 0.179" and 0.181")
5. Add algebraically the coded thicknesses in subgroup 1; place the sum (here + 1) opposite subgroup number one and under column headed Sum on the right hand side of the form.
6. Multiply the sum by 0.2* to obtain the average deviation of the subgroup values from the coded value of zero. Place the result, 0.2, in the Average column.
7. Obtain the range for the subgroup and place the value in the last column to the right headed Range.
8. Repeat steps 4 through 7 for each of the subgroups of 5 measurements.
9. Add the columns of averages and divide by the number of subgroups to obtain the coded average thickness for the sample (here + 2.9). This may also be a minus quantity.
10. The true average for the sample is obtained by adding the decoded value 0.0029" to the estimated average 0.77".
11. The average range is obtained (0.0075") and multiplied by 1.3† to obtain three sigma limits (± 0.0098" rounded to 0.1 ")

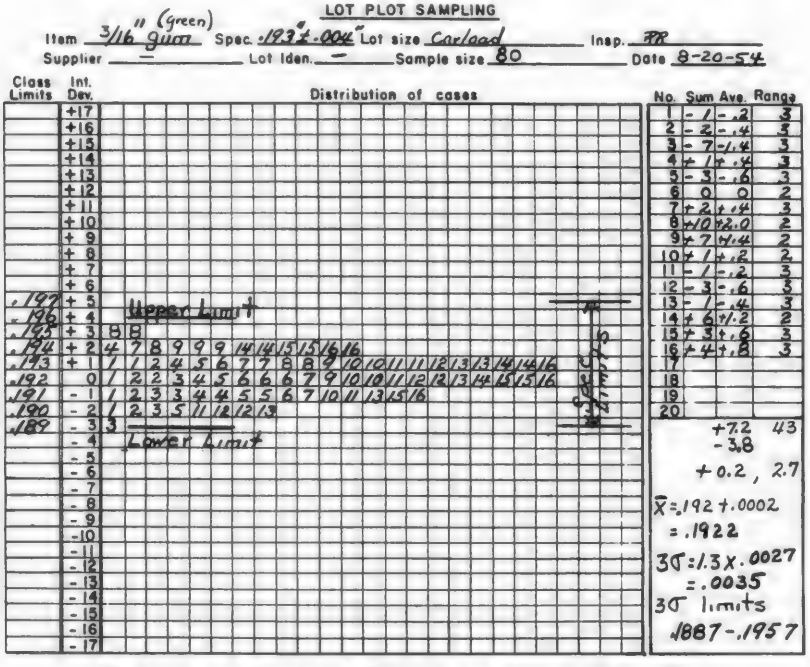

Fig. 2.—Green thickness of 3/16-inch gum obtained at the lathe.

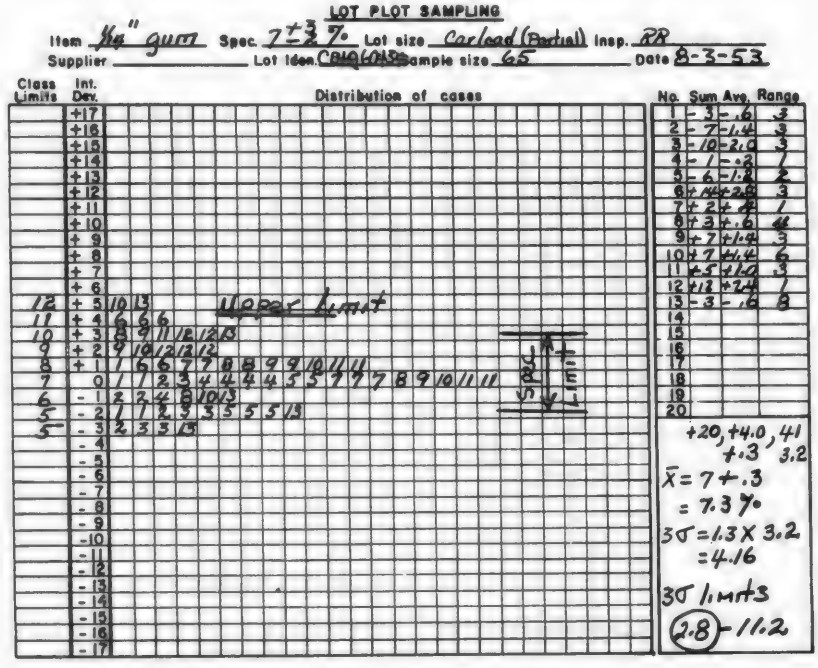
LOT PLOT SAMPLING
Item 1/4" gum Spec. 7 ± 3 % Lot size Carload (Partial) Insp. RR
Supplier — Lot Iden. CRIO/0/53 Sample size 65 Date 8-3-53
Class Limits
Int. Dev.
Distribution of cases
No. Sum Ave. Range
Upper Limit
+20, +4.0, 41
+.3 3.2
X̄ = 7 + .3
= 7.3 %
3σ = 1.3 X 3.2
= 4.16
3σ limits
2.8 - 11.2

Fig. 3.—Distribution of moisture content measurements of 1/14-inch gum veneer at time of delivery.

* $\frac{+1}{5}$ Algebraic sum of subgroup coded numbers / No. of items in subgroup

12. The sample limits and average are plotted on the frequency distribution along with those specified for the product.

Examples, Interpretations, and Use of Lot-Plots

The first requirement that the lot-plot must meet is that of showing a close approximation to a normal distribution pattern. The check is usually visual. If the distribution pattern is considered to be normal, the tolerance limits (three sigma) for the lot may be compared with specifications. When the quality control department is busy with specialized studies, or has a heavy work load of incoming veneer, it is a temptation to rely on a purely visual comparison as a basis for acceptance or rejection of the lot. The Jamestown Plywood Quality Control group felt that it was important to analyze each lot statistically in order to discover the unfavorable trends in thickness and moisture quality that might escape notice in a simple visual study. Figs. 1–5 are plots of thickness and m. c. distributions for lots of veneer received by the company.

Fig. 1 shows a distribution pattern that appears to be normal. The lot tolerance limits of 0.170″ to 0.190″ are wider than the specifications of 0.176″ to 0.192″ for 3/16-inch veneer thickness. In addition the average is 0.004″ too low. In such cases the supplier is asked to raise the average and reduce the spread.

Fig. 2 presents green thickness readings of 3/16-inch gum veneer taken at the time of cutting. Although the lot plot was not designed for this purpose, it was used by the company and the results were satisfactory. Fig. 2 has a normal distribution pattern, with an average 0.008″ greater than the specification for dry veneer. We can expect this lot of veneer to shrink 0.0092″ radially if dried to an average meter reading of 7½.

Valuable information regarding radial veneer shrinkage can be obtained by comparing green thickness and dry thickness lot plots. Such data are invaluable in establishing realistic thickness specifications.

The veneer mills sent carbon copies of the green thickness lot plots to Jamestown each day by air mail. Thus management was constantly informed of the day-to-day operation of the rotary veneer lathes.

Fig. 3 gives the distribution of moisture content measurements, on 1/14-inch gum. Although in most instances a normal distribution should be achieved, the skewness noted here is expected due to the limit of zero on the low side of the distribution and to the limitation of the moisture meter. The meter used was not capable of providing measurements below 5 per cent. When skewness is a problem in moisture measurement distribution it can be overcome by means of a logarithmic transformation described by Pratt (7) and Latimer.[3]

The moisture content of the veneer represented by the data in Fig. 3 was judged to be acceptable when compared to the specifications. The purchaser must recognize that the amount of moisture variation, or range of moisture content, is influenced to a considerable extent by the moisture specifications which he imposes on the veneer supplier.

For example, if a given purchaser specifies 9 per cent average moisture content for 3/16-inch gum veneer, the veneer driers used by most veneer mills will produce veneer with

[1] The factor 1.3 is used to convert average range to three sigma limits for individuals when R is determined for subgroups of five measurements.

[3] Lecture given at State University of New York College of Forestry, Short Course in Quality Control, April 1955.

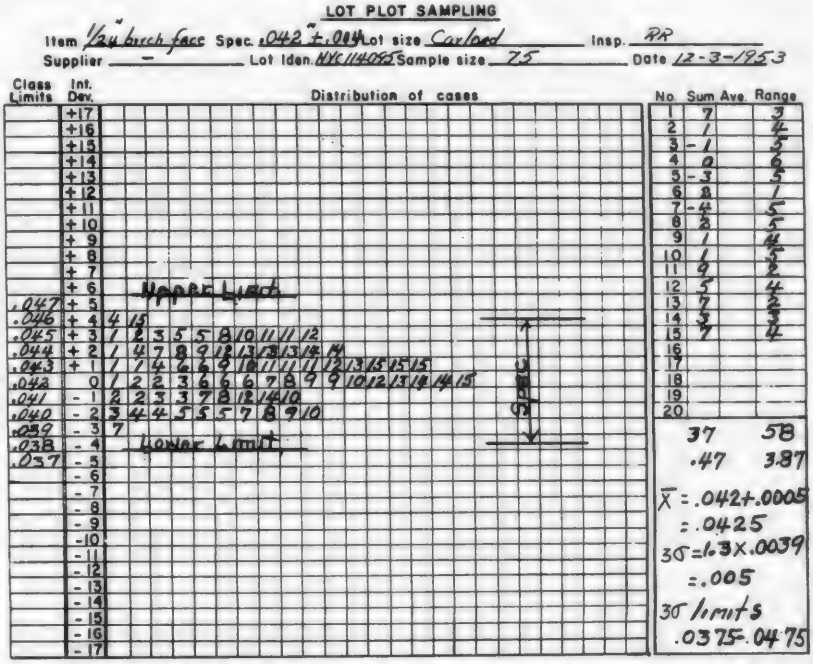

Fig. 4.—Distribution of thickness measurements on 1/24-inch birch veneer from supplier "A".

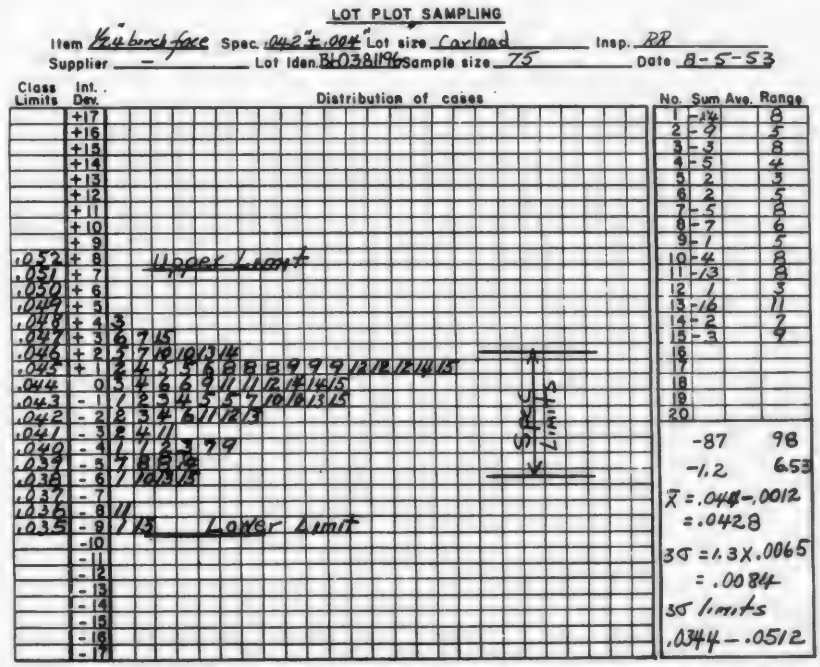

Fig. 5.—Distribution of thickness measurements on 1/24-inch birch veneer from supplier "B".

much more moisture variation (higher range) than would be the case if 5 per cent were specified. A widely accepted measure of variation or dispersion is the standard deviation. The following chart indicates the relation of moisture variation to average moisture in the case of 3/16-inch gum veneer.

Class Interval Moisture Meter Readings ($\bar{x}$)	Average Standard Deviation (σ)
6.00- 6.99	1.91
7.00- 7.99	2.19
8.00- 8.99	2.27
9.00- 9.99	2.62
10.00-10.99	2.97

Figures 4 and 5 give a comparison of the performance of two suppliers of 1/24-inch birch veneer. The performance of the supplier of the veneer for which the plot of thickness measurements is given in Fig. 4 is decidedly superior. Although the averages are similar and quite acceptable, the variances are significantly different. Consistent and continued differences between suppliers provide a basis for establishing preferences in regard to sources of material.

Almost without exception, Jamestown Plywood's own birch and gum mills performed far better than outside sources in regard to thickness control.

Conclusion

The information obtained by use of the lot-plot has served many purposes. A more suitable set of specifications was drawn up, a reduction in out-of-specifications goods was accomplished, the amount of inspection was minimized, misunderstandings between vendor and purchaser were reduced, and more reliable vendors were chosen.

Transmitting the information to suppliers and the shorter time required to get the same results by use of lot-plot are matters of vital importance. The advantage of the method used has been expressed by Shainin (6) as "rapid and easy correction of the production of out of specification material is a feature of the easily interpreted lot-plot distribution carbon copy, which can be dispatched, without even the time for a letter of transmittal, immediately upon the inspection of 50 parts."

The lot-plot method is one of the few tools of quality control that is readily understood by management. It is simple to operate with inexperienced help, has a high visual value, and lends itself to statistical analysis.

It seems reasonable to believe that the lot-plot could be used to great advantage by other wood processing plants and on other products.

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The Nature of Aspen Lignin[1]

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The nature of the lignin of aspen is discussed in the light of recent studies on aspen spent sulfite liquor, aspen "isolated native lignin", extractives of aspenwood, and completely extracted aspenwood. The effect of change from spruce to aspen in the sulfite pulp industry on the utilization of spent sulfite liquor is noted.

Introduction

DURING THE PAST SEVERAL DECADES considerable attention has been given to the chemical utilization of the lignin wastes of the sulfite pulping industry, and the literature is abundant with suggestions for the recovery of valuable chemical by-products.

Among the several factors responsible for much of the research in this field have been the need for conservation in order to meet expanding requirements for our raw materials, the urge for more economical production in the face of higher operating costs, and the pressure for abatement of effluents that are regarded as constituting a public nuisance. Substantially all of the research on spent sulfite liquor has been performed on liquors from the pulping of coniferous woods such as spruce or hemlock, woods which traditionally have been associated with sulfite pulping.

Within the last ten years the picture in the Lake States has changed. The shortage of native spruce, the high freight rates on imported spruce, and the threatened embargo on spruce by the Province of Ontario together with the large price differential have led many of the sulfite mills in this area to the pulping of the two indigenous aspens, namely quaking aspen *(Populus tremuloides)* and bigtooth aspen *(Populus grandidentata)*.

The spent liquor from the sulfite pulping of aspen presented new problems in the field of utilization. Many utilization schemes evolved over the years for coniferous liquors were found to be unamenable to aspen liquors. In fact, most of the conventional methods for the analysis of and separation of components from spent sulfite liquors gave anomalous results. These conditions led to the initiation in our laboratories by the Sulphite Pulp Manufacturers' Research League of a fundamental study on the nature of aspen spent sulfite liquor and of aspenwood with particular emphasis on the lignin content of both.

It is well known that aspen, like other deciduous woods, yields a Klason

[1] Presented at Session VIII, Chemical Utilization, FPRS Tenth National Meeting, June 4-7, 1956, in Asheville, N. C.

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or 72 per cent sulfuric acid lignin which contains 21 per cent methoxyl. Furthermore, it is known that the Klason lignin of aspen, like those of other deciduous woods, is composed of syringyl and guaiacyl structural elements, thus differing from the Klason lignins of coniferous woods which contain only the guaiacyl elements. Lignin chemists have always assumed that the lignin of deciduous woods is substantially identical with the lignin of coniferous woods except for the modifications of structural elements and combinations imposed by the syringyl moiety. In addition, it has been assumed that aspenwood differed from the more dense deciduous woods such as birch, beech, and maple only in the fact that its Klason lignin content was much lower.

Experiments in our laboratory over the past two years on aspen spent sulfite liquor, aspen "isolated native lignin", completely extracted aspenwood, and aspenwood extractives have indicated that the nature of the lignin of aspen does not agree with traditional concepts of lignin—even deciduous or hardwood lignin.

Fractionation Studies

Our first studies were concerned with fractionation of the components of aspen spent sulfite liquor. Ether extraction of the spent liquor yielded approximately 2.5 per cent extractives on the basis of liquor solids. These extractives were almost entirely phenolic in character as evidenced by paper chromatography. In addition, some of these extractives possessed aldehyde and carboxylic acid activity.

The chief component of the ether extractives of aspen spent sulfite liquor was found to be para-hydroxybenzoic acid. This was an unexpected discovery, because neither para-hydroxybenzoic acid nor even para-hydroxybenzyl groups had ever been reported in aspenwood. Most of the balance of the extractives comprised a mixture of guaiacyl and syringyl phenols and phenolic aldehydes.

Isopropanol Fractionation: Aspen spent sulfite liquor was fractionated by means of isopropanol. A concentrated commercial liquor was precipitated with isopropanol in the presence of diatomaceous earth filter aid. The resulting mixture was placed in a column and extracted successively with decreasing concentrations of isopropanol to give 19 fractions. These fractions were analyzed for methoxyl and for sulfur compounds. In addition, they were oxidized with nitrobenzene and alkali to yield syringaldehyde and vanillin. Sugars were analyzed by means of paper chromatography.

Fractionation results were entirely different from those obtained on similar studies on coniferous liquors. The first fraction contained all of the ether solubles in the liquor, and chromatographic analysis of these materials indicated the same compounds obtained in the direct extraction of the liquor with ether. Again, para-hydroxybenzoic acid was the chief individual component of the ether extractives.

Methoxyl and sulfonate sulfur analyses gave unexpected results. Carbohydrate-free fractions had methoxyl contents of less than 13 per cent in all cases. Methoxyl contents of these fractions were no higher, and in most cases they were less, than corresponding fractions from coniferous spent liquors. The same held true for the methoxyl-sulfonate sulfur ratios for the carbohydrate-free fractions. These results caused us to question the correctness of the 21 per cent methoxyl value for aspen lignin. More will be said about this later.

The results of the nitrobenzene oxidations of the 19 fractions indicated that the ratio of syringaldehyde to vanillin was not constant, and that the fractions having the greatest water solubility had the lowest syringaldehyde-vanillin ratios. Furthermore, a substantial portion of the syringaldehyde and vanillin obtained upon nitrobenzene oxidation of the entire liquor originated, not in the lignosulfonate fraction, but in the low molecular weight phenolic fraction. These data discredit attempts to arrive at some simple formulation for aspen lignin having a uniform ratio of syringyl to guaiacyl components.

In this fractionation study, the carbohydrate-free lignosulfonate fractions represented only a fraction of the lignosulfonate material originally present—the rest being present in carbohydrate-containing fractions. Another attempt to separate carbohydrates from lignosulfonates quantitatively utilized adsorption chromatography.

Cellulose Column Fractionation: Aspen spent sulfite liquor was chromatographed on a cellulose powder column and developed with a butanol-pyridine-water solution. Except for the concomitant fractionation of the carbohydrate portion of the liquor, the fractionation was no better than that obtained by isopropanol fractionation. The low molecular weight phenolic materials were identical with those noted above and yielded para-hydroxybenzoic acid as the main constituent.

Ion Exclusion Fractionation: The ion-exclusion procedure for the separation of ionic from nonionic materials was known to be effective in the separation of carbohydrate from lignonsulfonates in coniferous spent sulfite liquors. A great many attempts by this technique to effect such separation on aspen spent liquor failed to give the desired fractionation. The only fractionation accomplished by the ion-exclusion experiments was the complete separation of the low molecular weight ether-soluble phenolic materials from the mixed water-soluble carbohydrates and lignosulfonates.

Methoxyl of Aspen Lignin

On the basis of the relatively scanty information available on the chemistry of deciduous woods (as compared with the chemistry of coniferous woods) it has been generally assumed that the lignin of deciduous woods contained approximately 21 per cent methoxyl. In fact, as noted earlier, lignin determined on deciduous woods by the Klason or 72 per cent sulfuric acid procedure usually contains 21 per cent methoxyl. In those instances where 72 per cent sulfuric acid did not yield such a high methoxyl value, the sulfuric acid concentration was changed to that concentration which did give the higher methoxyl value.

If the 21 per cent methoxyl value for deciduous wood lignin is the true value for all deciduous woods, lignosulfonates obtained from the spent sulfite liquor of such woods should contain as high as 18–19 per cent methoxyl. This would be analogous to the 12–13 per cent methoxyl values for coniferous lignosulfonates obtained from coniferous lignin having a methoxyl content of 14.8 per cent. The failure of our isopropanol lignosulfonate fractionation of aspen spent sulfite liquor noted above to yield lignosulfonates of methoxyl content higher than 13 per cent led us into a study of the fate of aspenwood methoxyl in the sulfite cook.

Methoxyl Balance of Sulfite Cook: Extracted quaking aspenwood chips were pulped with a sodium-base bisulfite cooking liquor under closed conditions, and all portions of the resulting mixture were analyzed for methoxyl content. Over 95 per cent of the methoxyl originally present in the wood chips was recovered in the pulp and in the spent sulfite liquor solids.

This finding, along with a very low methanol value for the volatiles in this cook, refutes the commonly accepted idea that considerable methoxyl is split off as methanol during the sulfite cook. Therefore, at least in the case of quaking aspen, the discrepancy in the methoxyl values of the Klason lignin and the methoxyl values of lignosulfonates obtainable from the same wood cannot be due to splitting off of methoxyl from the lignin during the sulfite cook.

Approximately one-third of the methoxyl initially present in the original wood chips was associated with something other than Klason lignin or extractives. It is possible but, very improbable that this amount of methoxyl is associated with carbohydrate material. If some of this methoxyl is not associated with carbohydrate material, it must be associated in the spent sulfite liquor with lignosulfonate material, and therefore, it must be associated in the original wood with lignin material.

The low methoxyl value for aspen lignosulfonates so far obtained together with the fact that more methoxyl is present in the lignosulfonates of aspen than is present in the Klason lignin of aspen leads us to question the status of aspen Klason lignin as a measure of the lignin in aspenwood. Our experimental results indicate the possibility of true aspen lignin being present in aspenwood to the extent of 24–25 per cent with an over-all methoxyl value in the lignin of 15–16 per cent. Obviously, during the Klason lignin procedure a portion of the true lignin of lower methoxyl content than the residual Klason lignin is split off as materials soluble in the Klason lignin filtrate.

A methoxyl balance was made on the Klason lignin determination of quaking aspenwood meal. A sample of the meal was extracted with 2:1 benzene-ethanol and then submitted in replicate to the standard Klason lignin determination. All filtrates and volatiles were collected quantitatively for methoxyl determination.

The methoxyl recovery on the extracted wood meal basis was 100 per cent and only 7.5 per cent was recovered as methanol in the volatiles from the Klason lignin filtrate. Thus, 92.5 per cent of the original methoxyl was recovered in the Klason lignin and in the solids of the Klason lignin filtrate. The methoxyl in the Klason lignin comprised only 65 per cent of the methoxyl in the original extractive-free wood.

Para-Hydroxybenzoic Acid in Aspenwood

Chromatography of the benzene-ethanol extractives of the quaking aspenwood meal indicated para-hydroxybenzoic acid as a major component. The finding of para-hydroxybenzoic acid as an entity in these neutral extractives of quaking aspenwood indicated that the para-hydroxybenzoic acid found above in the various extractions and fractionations of aspen spent sulfite liquor might have originated in the extractives of the original wood and not in the lignin. Furthermore, the finding of this compound *per se* in the neutral extract of aspenwood under nonhydrolyzing conditions indicated that it occurs in the wood in the free acid state. The para-hydroxybenzoic acid found in the benzene-ethanol extractives does not account for all of the para-hydroxybenzoic acid groups in the wood, because chromatography of the Klason lignin filtrate also yielded the compound.

In this connection it is interesting to note the recent paper by D.C.C. Smith (J. Chem. Soc. 1955, 2347). Smith extracted an European aspenwood meal *(Populus tremula)*, which had been previously extracted with cold methanol, with both cold and hot sodium hydroxide solutions. The alkaline extracts were found to contain para-hydroxybenzoic acid. In addition, Smith prepared "native lignin" from *Populus tremula* and found that this material also gave para-hydroxybenzoic acid on alkaline hydrolysis. On the basis of these experiments and some rate studies on the hydrolysis of "native lignin" and several model compounds, Smith proposes that the lignin of aspenwood contains para-hydroybenzoate groups esterified with aliphatic hydroxyl groups of lignin.

Smith's work on *Populus tremula* wood and "native lignin" has been repeated on quaking aspenwood and "isolated native lignin" and the experimental results have been confirmed. However, in view of our finding para-hydroxybenzoic acid *per se* in the neutral benzene-alcohol extractives of aspenwood, and in view of the very low yield of "native lignin" together with the fact that "native lignin" of aspen is a name given to an extractive fraction, our conclusions do not agree with those of Smith.

Our results do not rule out Smith's hypothesis that the lignin of aspenwood contains para-hydroxybenzoate groups esterified with aliphatic groups of lignin, but they certainly suggest other possibilities. They indicate that some, if not all, of the para-hydroxybenzoic acid found on alkaline treatment of aspenwood may not be associated with lignin at all.

At present a large scale program on the chemistry of aspenwood and aspenwood extractives is underway, and results will be forthcoming in the near future.

Summary

Experiments on aspen spent sulfite liquor, aspen "isolated native lignin", completely extracted aspenwood, and aspenwood extractives indicate that the nature of the lignin of aspenwood does not agree with traditional concepts of lignin — even hardwood lignin.

Ether extraction of aspen spent sulfite liquor gave approximately 2.6 per cent extractives on the basis of liquor solids, and the chief component of the extractives was *p*-hydroxybenzoic acid. *p*-Hydroxybenzoic acid was also found in the extractives obtained by direct extraction of sound aspenwood with neutral solvents such as benzene-ethanol.

Analytical values on fractions obtained from aspen spent sulfite liquor indicated that the lignin in aspen must have an over-all methoxyl value of less than the commonly accepted value of 21 per cent. Methoxyl balances on sulfite cooks of aspen indicated very little loss of methoxyl, and methoxyl balances on Klason lignin determinations of aspen demonstrated that only two-thirds of the methoxyl originally present in the wood is recovered in the Klason lignin precipitate.

The significance of *p*-hydroxybenzoic acid to aspenwood and aspen lignin is discussed.

Discussion

Edward G. Locke (U. S. Forest Products Laboratory): In cooking aspen by the sulfite process, what per cent solids and carbohydrates are found in the spent liquor?

Dr. Pearl: The percentage is about the same as spruce cooks. Carbohydrates are high in pentosans, of course.

Fred Meyer (Dow Chemical Co.): Does the discovery of para-hydroxybenzoic acid have commercial possibilities?

Dr. Pearl: I don't know as yet. It can be obtained in very pure yield.

Dr. Locke: What per cent by weight of aspenwood does *p*-hydroxybenzoic acid represent?

Dr. Pearl: 2 per cent by caust cook.

Future Demand For Forest Products[1, 2]

PANEL DISCUSSION

Representatives of various segments of the forest products industry discuss meaning to their industry of the Stanford Research Institute report to Weyerhaeuser Timber Company on "America's Demand for Wood—1929–1975." Trends in plywood, furniture, and lumber industries are compared with projections in the report.

IMPLICATIONS OF THE 1954 Stanford Research Institute report to Weyerhaeuser Timber Co. on "America's Demand for Wood—1929–1975" was the subject of the following panel discussion. Moderator was Dr. Frank H. Kaufert, Director, School of Forestry, University of Minnesota, St. Paul, Minn. (current FPRS President-Elect). Paul B. Shoemaker, Vice-President, Sales, Masonite Corp., Chicago, represented the hardboard industry; and Earl C. Swanson, Vice-President, Andersen Co., Bayport, Minn., represented the millwork industry.

Plywood Industry

WILLIAM E. HUNT

Vice-President of Sales, U. S. Plywood Corp., New York, N. Y.

Before getting involved in the implications of the Stanford Report, it might be well to go back to the report itself for a review of some of the facts which have been presented as far as the involvement of plywood is concerned. Particularly in the case of our industry, the report points up many things which must be done if the forecasts contained in it are to be realized or exceeded.

Hardwood plywood production is expected to grow from 1.4 billion square feet in 1952 to 2 billion feet in 1975. Softwood production in 1952 was 3.3 billion square feet on a 3/8-inch rough basis and is expected to grow progressively to 4.6 billion in 1960, 5.5 billion in 1965, and 7.5 billion square feet in 1975. As a sidelight, it is interesting to note that the actual production of the softwood industry in 1955 ran about 5 billion feet and in 1956 was expected to rise another 250 million to 500 million square feet. That would mean that the year 1956 would show the softwood plywood industry producing as much material as the Stanford report predicts will be produced in 1965. Actually, these figures are not surprising in view of the dynamic nature of our economy and also what the experts predict will be its nature in the two decades to come. All of these predictions and facts, of course, are colored with a proviso that we keep our heads.

What does this mean? Mainly, we must maintain in existence sound monetary policies as a stabilizing influence on the economy. Such things as margin requirements, credit, interest rates, etc., are being used now by Mr. Martin and Mr. Humphrey and we should be glad they are using these instruments and support them in their efforts.

Other Industrial Growth

Deviating a bit from the subject of plywood on the basis that there is a corollary, I might relate a few things which developed in Washington on November 4, 1955, when I attended the Building Products Executive Conference. Frederick B. Warren, Assistant to the Executive Vice President, General Dynamics Corporation, told us that in 1955 atomic power plant construction would involve an expenditure of approximately $75 million. He predicted that by 1961, the annual investment in this type of thing would be approximately $1.3 billion. Bear in mind, this is all new construction.

G. Donald Kennedy, President of the Portland Cement Assoc., said that in 1945, the cement industry produced only 100 million barrels. It was expected that the final figure for 1955 would be around 300 million barrels and he told us that expansion in the industry will make possible production —but more important, the need for— 400 million barrels by 1965.

Ray E. Estes, Director of the Commercial Research Division of U. S. Steel, first related a few figures with regard to the gross national product, which was expected to be approximately $392 billion in 1955. By 1956, it will go to $400 billion, and by 1965, $500 billion. He related further that he expects our economy to produce a whopping $635 billion in 1975. These things, of course, are all important to the research on steel expansion and production which he contends will experience a continued dynamic growth. I believe the 1955 figure was about 102 million tons of steel. From 1960 to 1965, it is expected to exceed 117 million tons and go to 150 million tons by 1975.

These are the reasons why the forecasts which are shown in the Stanford report for plywood are not particularly surprising, nor should they be for the other products which are involved. This does, however, lead us into the availability and quality of the timber which will be available to support this increased growth in our industry.

Timber will be available so that makes quality the most important factor to consider. This involves not only the quality but the location of the timber and the expense of getting it out of the relatively inaccessible areas. It involves the size of the logs and also the quantity of the wood per acre. That these factors also affect the production of plywood and manufacturing costs is obvious.

Trends in Plywood Usage

There are other important facts in the report which should be considered before getting to the implications. These pertain to the trends in the use of plywood for: (1) new residential construction, (2) non-residential construction, and (3) manufactured products.

First, in residential construction, plywood has been gaining favor. Assuming non-decorative applications only, in 1920 the average house used only 48 square feet of plywood on a 3/8-inch rough basis. This increased to 66 feet by 1930, 201 feet by 1940, 642 feet by 1950, and 1,419 square feet in 1953. The projection shows 1,780 feet by 1960, 1,960 feet by 1965, and 2500 square feet per house by 1975.

It is also pointed out that hardwood interiors are likewise gaining in favor, although domestic production is being affected some by imported materials which are lower in cost and hence seem to have somewhat of a deterring effect. My opinion is that the long-run advantages of acquainting more people with hardwood plywood for house and building interiors may stimulate a greater demand for the higher quality, more decorative items which are the fruits of our own domestic production.

Second, let's consider non-residential construction. In this field, approximately 83 per cent of the plywood used is for concrete forms, 12 per cent is involved in trim and cabinet work, 3 per cent goes into wall paneling, and 2 per cent in miscellaneous applications. The increased usage has been rapid and in 1951 involved 148 mil-

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[1] Presented at FPRS North-Central Region Meeting, Nov. 15-17, 1955, in Chicago, Ill.

[2] The panel members reviewed this discussion in January 1957 and report that progress has been made in the past year on some products and methods mentioned. However, no major developments have occurred which would affect the implications discussed.

lion square feet, of which only 11 million feet was for farm service buildings. As yet, this is practically an untapped market, largely because it has not come in as yet for a great deal of advertising and promotion.

Concrete forms of plywood, however, face stiff competition from steel and hardboard, but it is felt that technological improvements such as plastic overlays, etc., will keep its use up where strength and smooth surfaces are required in one material. The use of plywood for maintenance and repair at present takes only about 15 per cent of the material used in nonresidential construction. It is forecast that this will increase considerably, largely because of the "do-it-yourself" trend and the fact that plywood lends itself nicely to easy applications of this nature.

Third, concerning the use of plywood in manufactured products, hardwood plywood appears to be four times as important as softwood plywood in furniture and fixtures. This obviously will increase, since for increased housing and increased nonresidential construction, furniture and fixtures are needed almost in proportion, to say nothing of the remodernization and replacement trade. The use of plywood, both hardwood and softwood, will also keep pace with the output of other manufactured products such as trailers, motor vehicles, trunks, boats and other types of shipbuilding, musical instruments, displays, games and toys, novelties, etc. As the whole economy expands, all of these things obviously expand with it and that includes plywood, which is an integral part of many of these things.

Implications for Plywood

There are, of course, many implications contained in the Stanford report. The following are a few of those which might be considered the most important.

Since the quality of timber available is being reduced every year, the process will be accentuated if the demand for the product increases. This obviously involves the use of lower grade logs and veneer than perhaps have been necessary in the past. That metamorphosis has taken place already to a large extent and fortunately the increased usage of plywood sheathing has taken care of the situation reasonably well.

However, to keep abreast of the other usages, it is implied that more must be done along these lines. How is it to be done? Uses for inexpensive but durable overlays to develop check-free and knot-hole-free surfaces are being developed and there is bound to be a good deal of progress in that direction. The industry also is going to have to develop better patching techniques to make the patches more durable and less obvious, especially for these applications where appearance is somewhat important. This might involve new shapes, new methods of matching, materials other than wood, etc.

The next obvious implication is the necessity to move toward lower costs of production. This, of course, is easier to talk about than to do, but some of the things which might be done are:

(1) Develop means of better raw material utilization so that greater yields of the raw material may be possible.

(2) Develop more extensive recovery from waste developed in the production of plywood. Many moves are presently on toward converting what formerly was fuel wood into pulp, particle board, hardboard, and possibly other products yet to be developed.

(3) Lowering labor costs, a battle which is never won, is being done through the development of new types of machinery and also methods which reduce the man hours required to produce a given unit of plywood.

(4) Develop methods of lowering the cost of usage for our material in the market place. This might involve factory-made parts such as roof sections for houses or other buildings, closet walls, and perhaps other component parts which lend themselves to easier and less expensive use by the builder in the field.

(5) It will be necessary to develop, in connection with full utilization of the forest itself, usages for species other than Douglas-fir which presently is the bell-wether and by which all of the standards have been set. Methods must be found to effectively use hemlock, larch, white fir, noble fir, and perhaps some others.

(6) It will further be necessary to develop usages for the lower grades of veneers which will be developed as the quality of the standing timber goes down. We have billions of feet of standing timber which contains a form of decay known as "white speck". Veneer cut from these trees has a potential economic usage, although probably not for structural purposes. Markets for this product must be developed, as well as markets for the grades of veneer which contain larger knot-holes than normally are allowed in even the D-grades used in sheathing.

(7) Exterior production is presently limited to the use of C-grade veneers on the premise that D-grade veneer has knot-holes too large to allow the pressure to breach the gap. I am confident that some method can be found to use D-grade veneer on certain types of exterior plywood.

(8) Plywood presently occupies only about 30 per cent of the wall sheathing market. This is up from 8 per cent a few years ago. Insulating board competition will retard plywood's gain because it is forecast that insulating board and hardboard will decline in price in relation to competitive materials which, of course, include fir plywood. Plywood sheathing production has been going up and it is obvious that it should by virtue of the turn in timber quality which has just been described. Hence, it is implied that other methods of using the lower quality veneers or sheathing grade plywood must be found.

(9) The same thing is true as far as usage for sub-flooring is concerned. This was up from 8 to 25 per cent of the sub-flooring market between 1950 and 1953. However, it is pointed out that technological improvements in hardboard will retard the rate of growth. It should be noted that this is the rate of growth and not the actual growth of its usage in this field.

(10) From an economic standpoint, the use of plywood sheathing should continue to grow in relation to lumber, but lose some ground in relation to hardboard and insulating board, unless methods to lower the comparative production costs in these respective materials can be found.

(11) It is most obvious that more, better, and accelerated research in machinery, use of manpower, and product development is necessary. I feel certain that all of these things will be forthcoming in such a manner as to meet or exceed the forecasts listed in the Stanford report.

Lumber Industry in the Lake States

ROBERT KOLBE

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Before discussing the significance of the Stanford Report for the industry, perhaps we should restate the broad assumptions on which this report is based:

1. There will be no all out-war during the period covered by this study; however, a high level of military preparedness will continue.
2. There will be no radical advances in technology to increase productivity at a higher rate than in the past.
3. There will be a greater degree of stability in business cycles in

future years than in the past 25 years. This stability will be accompanied by high but not full employment.

It is further pointed out that by 1975 the population of our country will increase approximately 34 per cent, the employed civilian labor force from 63 million to 88 million, and the value of the gross national product increased by some 70 per cent.

With these key assumptions in mind, we come to a discussion of the implied future of the lumber industry in the Lake States.

Factors Affecting Consumption

There are three factors which influence forest products consumption—price of product, distribution, and substitution.

There is no doubt that the price of lumber will gradually increase because of:

1. Increases in costs of stumpage.
2. Increases in logging costs resulting from cutting a lesser volume per acre and a smaller run of logs.
3. Increased manufacturing costs because of rising labor costs and declining size of logs.
4. Finally, an increase in distribution costs.

The Stanford report points out that lumber prices will probably rise more rapidly than the prices of competing materials, but the relative increase is expected to be smaller in the 1952–1975 period than it was between 1929–1952.

Distribution costs—of which the greater part is in transportation of the product from manufacturer to consumer—seem destined to increase also.

It is predicted that the consumption of lumber per dwelling unit will shrink from 10,500 board feet in 1953 to 8700 board feet in 1975. Some of this decrease is, of course, caused by the changing designs of buildings. Substitutes are also causing shrinkages in lumber consumption in non-residential construction, shipping materials, and manufactured products.

While predicting the continuing decline in per capita consumption of lumber, we are reminded of that 34 per cent increase in population with its accompanying rise of some 70 per cent in value of gross national product. Lumber will share in this increase.

Conclusions

Summarizing briefly, the outlook for the Lake States lumber industry for the next two decades is about as follows:

1. The price of lumber will increase although less rapidly than in the past.
2. Substitutes will continue to take away part of our business.
3. Despite the above facts, there should be a market for all lumber produced in the region.

It is further indicated that the industry must constantly increase its efficiency in growing, protecting and harvesting the trees, and in manufacturing, packaging and distributing the product.

Industrial forestry in the Lake States is moving forward with great strides, and through the industry-sponsored Tree Farm Program, progress is being made in encouraging owners of small woodlots to better manage their timber lands.

Furniture Industry

J. G. GRISWOLD, JR.

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At the 1955 NAFM National Convention, Arno H. Johnson, Vice-President and Director of Research of the J. Walter Thompson Company, outlined the tremendous potential in the furniture business during the next 10 years. He analyzed President Eisenhower's 1955 economic report to Congress and concluded that the report was conservative. It pointed out that our country within a decade can, and probably will, increase its production from the current annual level of about $390 billion to $500 billion or more. Then, on the basis of his analysis of the trends in family life, the increase in home ownership, the movement upward in income groups, and the resultant increase in discretionary spending power, Mr. Johnson concluded that the furniture industry will have the opportunity to double the present level of sales to consumers in the next 10 years.

J. G. Griswold, Jr.

I repeat that he said the industry will have the *opportunity,* recognizing the fact that our industry must qualify to that opportunity, and recognizing that competition for the consumer dollar in the years ahead will be very intense. We will be competing not only with the obvious products on the market, such as automobiles and household appliances, but also with beefsteaks and trips to Europe.

Mr. Johnson's conclusions are mentioned to indicate that the forecasts in the Stanford report are probably conservative. That report predicts that manufacturers' shipments of household furniture may be expected to double in the next 20 years, the rise being from the current annual level of about $2½ billion to approximately a $5 billion level in 1975. It seems clear that a tremendous growth in furniture production is ahead, that we may possibly be doubling dollar volume within 10 years and very probably will be doing so within 20 years.

In view of that anticipated growth, let's see what the Stanford report had to say specifically about the furniture business. It might be observed that it did not concern itself too much with our industry. It is concerned more in detail with softwoods than it is with hardwoods, which is understandable inasmuch as it was done for the Weyerhaeuser Timber Company. It talks about three forest products—lumber, pulp, and plywood—which make up 90 per cent of the total wood requirements, the demand for which is primarily in three principal fields—construction, shipping materials, and manufactured products.

Forecast for Furniture

Manufactured products today account for about ⅛ of the United States lumber consumption, about ½ of which is used in furniture manufacturing. Twenty years from now it is forecasted that the use of lumber in all manufactured products will go up slightly and the importance of furniture in this group will go up considerably, representing 2/3 of lumber use in this category by 1975. This gain by the furniture and fixtures group is offset by losses in house-trailers, Venetian blinds, agricultural implements, handles, ladders, tanks, pencils, toys, and other products.

The furniture industry is, of course, somewhat concerned with the category of shipping materials. However, this seems less important to us as the years go by because today large amounts of furniture are moved uncrated, cartoned, or wrapped, whereas 25 years ago almost all furniture was shipped in crates. I look for this trend to continue.

It is interesting to note that while the Stanford report expects furniture dollar volume to double in the next 20 years, it forecasts a lumber consumption increase of only 74 per cent. In other words, it expects a drop of 11 per cent in board feet of lumber per dollar output. Although I would not be able to argue the specific percentages, I would be inclined to go along with the general conclusion because of the following trends.

Trends Affecting Outlook

I have mentioned the trend in crating and cartoning. The trend in designing of furniture would seem to be another reason. Inroads by competing materials will undoubtedly continue, and as the Stanford report says, "this competition from other products will probably grow increasingly keen as time goes on". The use of metal and plastics in completed furniture or furniture parts will undoubtedly continue to grow, although I agree with the report that the major effects of such competition may have already been felt and that in the 20 years ahead the increase in the use of non-forest products in furniture output may be expected to be at a considerably less rapid rate than in the past. It is significant that metal furniture was about 4 per cent of total furniture production in 1929, and about 17 per cent in 1951. Since then, however, metal furniture has declined slightly to 16.7 per cent and I do not believe that non-wood furniture will continue to increase at the same rate that it has in the immediate past. In other words, it isn't likely that non-wood participation in the furniture market will quadruple in the next 22 years as it did from 1929 to 1951.

Finally, the substitution of such products as hardboard and chipboard will undoubtedly continue to grow and reduce the amount of lumber as such in wood furniture. The report cites an expected 20 years' growth of 140 per cent in the use of hardboard in furniture and fixture production.

Nothing is said in the report about the substitution of chipboard for lumber as core stock for furniture. This seems to be an important omission because already that type of board is being used to some extent in furniture and it is my belief that its growth will be very significant in the next 20 years, possibly replacing lumber altogether for that use. Since core stock is the biggest single lumber use in a large segment of our industry, the part that chipboard will play should not be overlooked.

Future Timber Supply

The Stanford report deals with probable markets for forest products of the future without much reference to the availability of a continuing supply of those products. We in wood furniture manufacturing know that the timber quality outlook is not favorable. The Timber Resource Review by the U. S. Forest Service also points this out very clearly. Certain things in the Stanford report, however, suggest answers to possible shortages.

The importance of better forestry practices and better utilization of the products of the forest is vital to us all. The late J. P. Weyerhaeuser, Jr., in commenting on the report, put it this way: "The various forest industries are already alert and will be increasingly alert to the possibilities of improved forestry and logging practices, and new technical developments for harvesting the whole forest crop and for using all the materials that come to the mills from that crop. As competition and technical developments proceed, more and more products will be made with relatively less drain on the forests, so that available timber supplies will stretch much further than would have seemed possible in the past." The Forest Products Research Society is to be congratulated on its efforts in that direction.

We have a great opportunity and a great challenge in the next 20 years. Although other industries are larger in the overall consumption of forest products, still the furniture and fixture manufacturing industry may be expected by 1975 to consume annually 780 million square feet of hardboard, 2¼ billion square feet of plywood, and nearly 4 billion board feet of lumber. Certainly these are tremendous figures. We will strive to use these materials efficiently and well.

Customer-Producer Relations in the Particle Board Business[1]

ALEC M. FISKEN

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Outlines procedures for evaluating what particle board customer thinks he needs vs. what he really needs, and modifying products to meet these requirements without disturbing customer-producer relationship. Demonstrates necessity for understanding customer's problems and emphasizes need for flexibility and process control in the producing plant.

IN THE QUICKLY EXPANDING BUSINESS of manufacturing and utilizing particle board, much emphasis has been placed on the manufacture of products to specifications based on the producer's raw material and installed plant equipment. Hence we have been working in many cases with a product which is convenient to produce and one which we hope will satisfy a sufficient number of customers to allow the plant to continue profitable operation.

The recent increase in the number of producers together with an increasing knowledge on the part of consumers with respect to particle board properties and use characteristics will soon bring us to the point where producers must take a new look at the customer-producer relationship in order to develop markets for the expanding production of particle board.

The relationship is demonstrated in four products: (1) The product which the customer *thinks* he needs. (2) The product which the customer *really* needs. (3) The product the mill *currently produces*. (4) The product which the mill *could produce* through control of the process variables. Needless to say, if product (1) and (3) are the same there is no problem at the moment. Such a situation is not usual and it is the fortunate producer who finds himself in the position where (2) and (3) are the same item.

To establish the factual equality of (2) and (3) requires careful analysis of the use. Too often the suitability of a new product is judged by comparison with the existing and presumably satisfactory product and the customer's definition of what he desires or thinks he needs approaches a description of his currently used material.

The easiest approach to the problem is to send samples to the customer for trial, evaluation of the material, and

[1] Presented at FPRS Northeast Section Meeting, April 19-20, 1956, in Springfield, Mass.

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submission of new samples as indicated. Such a procedure has many disadvantages. Time is consumed in shipment and evaluation, customer good will may wear thin as unsatisfactory products are demonstrated, and finally, when and if success is achieved there is usually no clear cut explanation of why the board is successful nor is there any assurance that the product is not grossly overdesigned and the customer is paying for properties which have no significant relation to the product use.

Analyze Customer's Needs

Careful analysis of the job to be done without reference to the competition provides the only sound approach to an analysis of what the customer really needs. The first stage of such an analysis will provide a descriptive picture of the required product in terms such as "must have a smooth surface", "must resist moisture", "must be able to hold fastenings", "must not delaminate when surfaced", "must not show core pattern on surface".

Obviously such descriptions require additional definition before it can be established that the required product is the same as the board currently leaving the producer's plant. The second step in the analysis of what the customer really needs relates the generalized descriptive requirements to physical properties capable of measurement. Such property values may include modulus of rupture, screw holding, internal bond, water absorption, and many others as indicated. The analyst may well find that it is necessary to devise new test methods to describe important properties.

With the properties listed, the final problem involves the setting of minimum and maximum property values to provide a sales specification, which when met will provide a product of satisfactory characteristics. The selection of property values requires judgment, knowledge of the competition, and no doubt field trials. Here it is important to compare—with successful competitive values as a guide. The field trials should delineate the values actually required, and if the pre-trial work has been soundly executed it is unlikely that any gross deficiency will be found.

Most customers or board users will welcome the approach as outlined since tangible benefits should accrue. The user will in many cases obtain a better realization of his needs, he is saved the burdensome testing of unsatisfactory products, and he has at least some assurance that he is not paying for unneeded qualities.

Flexibility in Manufacture

With the relationship of item (1) "what the customer wants" to item (2) "what he really needs" established, it remains only to check the manufacturing specifications of what the mill produces (3) for compliance. In many cases the producer will find that the current production falls short of the requirements established. His ability to incorporate the desired properties in the board will certainly be a major factor in his ability to retain existing business or capture new business. This revision is demonstrated by the shift from product (3) to product (4). The new product (4) is so controlled as to meet the requirement of product (2), the material determined as that which the customer needs.

The flexibility required in changing the product is achieved in part by the basic plant design and raw material available and in part by the ability to control process variables during manufacture. In most instances the basic raw material will be fixed both as to wood species and within limits with respect to size and shape. The plant utilizing sawdust as raw material will of course have less inherent flexibility than one operating on planer shavings or block residuals.

Basic equipment limitations will include a maximum board width, length, and thickness, although we must not discount the possibilities of edge gluing and lamination to overcome such limitations in subsequent processing.

Assuming the above limitations, the typical plant will be in a position to control: particle size and shape, moisture content of particle, type and usage of binder and additives, weight per square foot laid down, press platen temperature, and press time.

More flexible plants may also be in a position to adjust the orientation of the particles and to take advantage of heterogeneous construction by the manufacture of three-layer or sandwich boards.

It is beyond the scope of these comments to examine in detail the specific effects of the variables. The two factors to be considered are first the ability of the plant operator to control closely the variables within the range of limits allowed by plant design and, second, adequate knowledge of the change in board properties resulting from changes in the variables.

The problem here is analogous to that described earlier in the discussion of the procedures involved in analyzing the use. It is entirely possible to make plant changes without prior knowledge of the degree of control possible or the resulting end product. Here, however, as before, the cut and try method results in high cost, uncertain ultimate success, and most important, inadequate knowledge of why success was achieved if one is fortunate enough to be successful. On the other hand, the planned approach to modifying board properties in the plant will minimize experimental expense and provide adequate tracks showing how and why the desired result was achieved.

Specifications Compared

Following the planned approach, the desired product specifications are compared with the current production specifications, and the properties which are out of line readily noted. The operator must then rely on his knowledge of the controllable process variables to determine which are significant for the properties in question. Once the significant variables are established, it remains to estimate the degree of change required to achieve the desired result.

At this point a plant trial is indicated to confirm the planning, and again if preliminary work has been sound the predicted product should be achieved. It goes without saying that if the required product clearly is outside the ability of the plant, the planning study should indicate this fact and no time and money expended in useless mill trials.

The above procedure cannot be followed unless the plant operator is equipped with the necessary tools, instruments, and personnel to adjust, measure, and record the data. However a complex system or a high degree of automation is not required if the operating personnel and management are alert to process control and understanding of its advantages.

In any program designed to produce a product to meet a customer's use, the economics must of course be kept in mind at all stages of the study. If the modified product cost is such as to raise the price above what the customer can be expected to pay, this fact should be realized early in the game. Hence a thorough knowledge of the effect of variable adjustment on manufacturing cost is essential to the solution of the problem.

Such information as the change in raw material costs, change in product rate hence unit costs, and possibility of added labor costs must be considered before offering the product for sale.

There remains the ultimate problem in producer-customer relations which faces the operator when a thorough study of the customer's needs and evaluation of the possible product modification in the plant indicates that the best the plant can do will still fall short of meeting the customer's requirements. In such a situation the producer must rely on his knowledge of the customer's needs and his own product to suggest changes in the cus-

tomer's procedures which will accomodate the best product he can produce.

Such changes need not be far-reaching or costly. Modifications such as a different type of screw for use in attaching legs to a dinette table, the substitution of an adhesive, reduction or increase in laminating pressure, or revision of edge finishing techniques may make the difference betwen success or failure. Moreover, any added cost in procedures may be more than compensated by savings achieved through the use of particle board, and at the same time an improved final product may result.

As installed plant capacity grows and particle board seeks to expand its markets into new uses, the customer-producer relationship will become more complex, and the careful evaluation of what the customer thinks he needs vs. what he really needs, together with the ability to tailor board products to meet these needs, will become increasingly important. These comments are designed to outline procedures by which such evaluations and modifications can be made with a minimum disturbance to the customer-producer relationship, to demonstrate the necessity for an understanding of the customer's problems, and to emphasize the need for flexibility and process control in the producing plant.

Cushioning Materials for the Protection of Furniture[1]

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Factors are explained which provide cushioning and surface protection in furniture packages. Interior packaging materials in common use and their desirable quality attributes are discussed. Load-distribution and shock absorption abilities are shown to be particularly important requirements of protective interior blankets. It is demonstrated that both are functions of the material's thickness rather than its weight.

THE MODERN TREND in packaging furniture for transit is rapidly moving away from heavy and expensive open wooden crates, built by hand to fit the product. Many leading furniture manufacturers have demonstrated that their product can be packaged more economically and given greater protection by wrapping it in a protective blanket and placing it in a close-fitting, double-faced corrugated fibreboard box which has a wooden skid attached to its bottom.

A furniture manufacturer shipping a wooden bureau or chest of drawers by railroad freight will be used as an example. Under the furniture packaging requirements of the Uniform Freight Classification No. 3, he would have a number of choices of methods of packing. These would include packages 1–F, 2–F, 3–F, 5–F, 21–F, 28–F, 30–F, 48–F, 68–F, or 71–F. They include containers constructed of double-faced corrugated fibreboard, fibreboard with an interior wood reinforcing frame, wooden crates, fibreboard with an exterior wood reinforcing frame, veneer crates, and plywood crates. The manufacturer would likely choose method No. 2 of the 2–F package. This might be described as a "pressure pack" in contrast to the "clearance packs" prescribed by most of the other methods.

The 2–F package requirements state that for the method No. 2 pack, all finished surfaces must be completely covered with a blanket which complies with the specifications of item 19501, Note 4, paragraphs (1), (2), (3), (4), (5), (10), (12), (14), or (23) of the Uniform Classification. The blanketed article of furniture is then placed in a close-fitting container made of double-faced corrugated fibreboard testing not less than 200 pounds. The container must provide a double thickness at the top, have bottom flanges or flaps at least 3 inches wide, and must cover the top and all four sides of the furniture. The furniture rests on a four-piece wooden frame, diagonally braced, which in turn fits into the base of the container. The bottom container flaps are folded over the wooden frame and mailed or stapled to it.

Types of Protective Blankets

As far as the protective blanket is concerned, any one of a number of types may be used for the 2–F package indicated by the varying paragraphs of Item 19501, Note 4 listed above. Those in common use include:

Macerated Paper Blankets — a Kraft paper envelope of 30-pound basis weight, sealed on all four sides, and filled with macerated paper to uniform thickness. The Kraft paper is coated with asphalt on its inner side in order to secure the macerated paper and prevent shifting. These blankets must weigh not less than 1 pound per 1000 square inches.

Shredded Paper Blankets—similar to the macerated paper blanket except that the filler is shredded paper and the minimum blanket weight not less than 2 pounds per 1000 square inches.

Wood-wool Blankets — similar to the macerated or shredded paper blankets except that the filler is wood-wool of not less than 120 knife cuts per inch manufactured of timber whose moisture content does not exceed 25 per cent. The blanket weight is to be not less than 1 pound per 1000 square inches.

Wood Fibre Felt Blankets—new wood fibers produced by a groundwood process, felted and bonded together into a homogenous mat of uniform thickness and surfaced on the outer side with 30-pound basis weight Kraft paper. The blanket thickness is to be not less than ¼ inch, and the wood fibre must weigh not less than 54 pounds per 1000 square feet.

Creped Cellulose Wadding Blankets—constructed of a number of plies of creped cellulose wadding, embossed for ply attachment, and surfaced on the outer side with 30-pound basis weight Kraft paper. The blanket thickness must be not less than ¼ inch. The cellulose wadding in the blanket must weigh not less than 56 pounds per 100 square feet except that when the wadding contains no asphalt or other binder and is made of not less than 60 per cent sulphate wood fibre, the weight of the cellulose wadding must be not less than 49 pounds per 1000 square feet.

[1] Presented at Session XIII, Packaging, FPRS Tenth National Meeting, June 4–7, 1956, in Asheville, N. C.

The Author: John A. Hoffman is a graduate of Marquette University and has been associated with Kimberly-Clark Corp. since 1941.

Figs. 1–3.—The three figures, left to right, show steps in packaging a typical "pressure pack" under the furniture packaging requirements of Uniform Freight Classification No. 3. Package is 2-F, which is most often used on case goods. Method is demonstrated by Ronald Turner, Kimberly–Clark Corp.

Cotton Wadding Blankets—a mat of cotton fibres, glazed on both sides, and weighing not less than 50 pounds per 1000 square feet.

Indented Paper Blankets — constructed of four thicknesses of indented paper with the indentations arranged to prevent nesting in each other, and one thickness of chip paper, not indented, on each side of the indented paper. All six thicknesses are enclosed in a sleeve of 30-pound basis weight Kraft paper. Each thickness of the idented paper and chip paper must have a basis weight of not less than 60 pounds, and the blanket thickness must be at least ¼ inch.

Wadding Laminated to Corrugated Fibreboard—double-faced corrugated fibreboard not thinner than A-flute, to which is laminated creped cellulose wadding. The wadding must be at least .06 inch thick, weight not less than 20 pounds per 1000 square feet, and be surfaced on one side with 20 pound basis weight Kraft paper.

Functions of the Protective Blanket

The blanket is present for only one purpose—to protect the finished surfaces of the furniture from being damaged by abrasion, pressure marking, or shock. To perform this function it needs to have two important abilities: load distribution and shock absorption.

Load Distribution: It is essential that the protective blanket be able to distribute high point loadings over a larger area, thus reducing the unit load at any point. For example, suppose the surface to be protected were in direct contact with the container (no blanket present), that the furniture surface area is 100 square inches, and through stacking a load of 100 pounds is applied to the container top. If the container board is a uniform flat plane and there are no high spots present, the unit load at any point of the furniture surface is 100 pounds per 100 square inches or 1 pound per square inch.

However, the container board is not a uniform flat plane. Close examination of its cross-section will show a high point where each corrugated flute joins the facing sheet. In addition, an abrasive particle, such as a cinder, may get in between the container and the furniture surface. In either case, the 100 pound total load would be acting on an area considerably smaller than the 100 square inches of furniture surface. If the high spot area were 1 square inch, for example, the load at this point would be 100 pounds divided by 1, or 100 pounds per square inch. This would be a sufficiently high load to damage the furniture surface.

If there were no movement between the container and the furniture surface, pressure marking or "printing" of the surface would result. Movement between the container and furniture surface would result in abrasion of the furniture surface at the high spot.

Now if we interpose between the container and the furniture surface a *compressible* material which has *thickness* sufficiently greater than the heighth of the non-uniformity, the material will compress at the high spot, and the 100-pound load will again be distributed over the entire area.

It can be demonstrated that the function of load distribution is related to the thickness of the cushioning blanket, and for any one type blanket the basis weight is of relatively little importance. For example, if we compare two different creped cellulose wadding blankets which are of the same basis weight but differing in thickness, the blanket with the higher thickness will do a better job of protection of a furniture surface because of its greater load distribution ability.

Shock Absorption: This is, of course, a comprehensive subject, and can be touched upon only briefly. A fundamental principle of shock absorption can be expressed as follows: "It is not the distance you fall that hurts you, it is how fast you stop." For example, if you were to fall from a second story window and land on your head on a concrete sidewalk, you would stop very fast—and probably would not get up. However, if you were fortunate enough to land head first in a pile of hay, you would probably live to fall another day. The pile of hay, being compressible and having thickness, provides a certain distance through which you travel while coming to a stop. It slows you down more gradually and you are subjected to less shock. This is the principle upon which all shock absorption materials must operate—decreasing the rate of deceleration by providing a distance through which the object travels while stopping. The greater the distance, the less shock the object is subjected to.

This distance traveled through while stopping is related to the compressibility characteristics and thickness of the cushioning material. For any type of material, it is not necessarily a function of the basis weight of the material. For example, it can be demonstrated that two creped cellulose waddings of widely differing basis weights will have equal shock absorption abilities, as long as their thicknesses are equal.

Effective Thickness: The cushion thickness referred to in this discussion, as well as that specified in the Uniform Freight Classification, is what we choose to call "effective" thickness. The effective thickness is the thickness as measured under a 3½ pound per square foot load. For many years no

standard method was available for measurement of thickness of cushioning materials. Considerable confusion from the standpoint of specification and purchase of these materials resulted from this. The U.S. Forest Products Laboratory was instrumental in the development and widespread acceptance of a standard method. It is now specified in Federal Specifications, American Society for Testing Material Standards, Railroad Freight Classifications, and many industrial purchase specifications.

Other Quality Requirements of the Protective Blanket: While the most important function of the protective blanket is to provide load distribution, other quality attributes are also desirable and necessary. In itself the blanket should be non-abrasive, non-staining, conformable, strong and non-linting or dusting.

Conclusion

Significant progress has been made in the furniture industry in the packaging of their products. This progress, as examplified by the use of corrugated fibreboard containers in combination with an inner protective blanket, has produced a less costly package which gives greater protection to its contents. Many materials are available for use as the protective blanket, whose main function is to provide load distribution to prevent abrasion or pressure marking. The degree to which the protective blanket performs this function is directly proportional to its effective thickness rather than to its basis weight.

Review of FPRS Section Meeting Papers

Facilities for Pulping Hardwoods in Northeast

C. P. Donofrio, State University of New York College of Forestry, Syracuse, N. Y. FPRS Northeast Section Meeting, April 28–29, 1955, Glens Falls, N. Y.

The anticipated expansion in requirements for wood pulp contemplates increased hardwood utilization through new processing methods and refinements in some of the existing ones. Hardwoods will be expected to contribute to the increments in wood consumption and also to compensate for the deficits expected in supplies of certain softwood types.

Many are hopeful that the combination, Northeast–Hardwoods–Semichemical, will help recover for the Northeast the leadership it once enjoyed in the paper industry. The key to success is semichemical pulping.

In the past 30 years, a few plants have been expanded in the Northeast and a number have been closed down. A portion of the latter are of the type which can be converted to semichemical operation.

At present there are about 90 or more groundwood and sulfite plants accounting for about 75 per cent of the Northeast pulp output. Most of the mills in the Northeast are small and much of the pulping machinery is old or obsolete. Hence, plant size and high wood cost make it difficult for many of these mills to compete with large and modern plants established expressly for producing market pulp. Lower wood cost can be achieved through the use of hardwoods and the resulting pulp can be used satisfactorily as components of many paper furnishes. Unfortunately, the Northeast lacks facilities for converting its hardwoods on any substantial scale.

Semichemical pulping covers a wide range of processing methods and embraces a wide variety of pulps. There are two major types. One is essentially a modification of soluble-base sulfite pulping, neutral sulfite semichemical (NSSC), and the other, a modification of the kraft process. In both cases varying degrees of high pulp yields can be achieved, depending on the type of pulp desired.

Whereas the Northeast has shown greater interest in the production of bleached NSSC pulps, there may be more promise in the development of operations for coarse semichemical, fine unbleached semichemical, Chemigroundwood, and a number of other methods where yields are high enough to possibly preclude any sizeable capital commitments for liquor disposal. This may make it possible to lower the minimum capacity of the operations to the convenience of some of the smaller paper firms.

It will be necessary in most cases to procure and install new papermaking machinery for the conversion of these pulps. This will have to be done in any event if the Northeast plans to utilize more of its hardwoods.

The Forward Look in Gluing

Joseph Coufal, National Adhesives, New York, N. Y. Panel Discussion, North-Central Regional Meeting, Nov. 15–17, 1955, in Chicago, Ill.

The past and present have shown that vinyl resins may be successfully employed as a rapid cold setting adhesive for joint work. This has included post building, mortise and tenon, dowel, blocked joints, and edge gluing for solids or lumber core. Extended vinyl resins have been employed widely for hollow and solid core flush doors, for plastic laminating, and for side panel to frame glue-ups.

The vinyl resin of the near future will be used in bonding veneers to lumber core with short clamp time and a one-hour cure period before machining. They will largely help to eliminate the cold press baling method using I-beams and retaining clamps. Their price will be competitive to present day low cost veneering urea resins. They will also be used for hot press work and for radio frequency in cabinet room assembly joints. They will have greater relative humidity, water immersion, and heat resistance than present day vinyl resins and at lower cost.

The large volume future lies in overlaying kraft papers, thin veneers, mylar-type films, and high pressure laminant sheetings to particle board and other cores on a continuous basis. They will be used in conjunction with machines which produce these cores on a continuous basis.

Future vinyl resins will have extremely fast speed of set so that they may be employed with a series of pinch rollers to effect almost immediate bonds on overlays for particle board. These vinyls will be fortified so as to have water immersion resistance equivalent to present 45 per cent solids urea resins. They will be able to be set cold, with heat or with radio frequency. They will be ready for use, requiring no preparation, will have a three to five day pot life, and will clean readily from the glue spreaders. They may be roller coated, hand brushed, or sprayed and will be non-toxic and non-inflammable.

Vinyl resin is currently being employed in the construction field to laminate various wallboards and plywood to studs for prefabricated homes and in trailer constructions. It will spread to prefabricated laminated floorings, honeycombed sandwich panels, and other types of prefabricated constructions for buildings.

Around the World in Forest Products Research and Development

World-Wide Forest Products Review

REVIEW OF THE TENTH YEARBOOK of Forest Products Statistics, prepared by the Forestry Division of the Food and Agriculture Organization, United Nations. Based on information received from more than 120 countries in 1955.

Logging

Total Fellings: Recorded removals of roundwood from the world's forests showed a further increase in 1955 from 1,424 million cu. m. in 1954 to about 1,465 millions or about 3 per cent. The output in North America rose by 20.5 million cu. m. In other regions, removals also showed a rising trend, especially in Europe, U. S. S. R. and Asia.

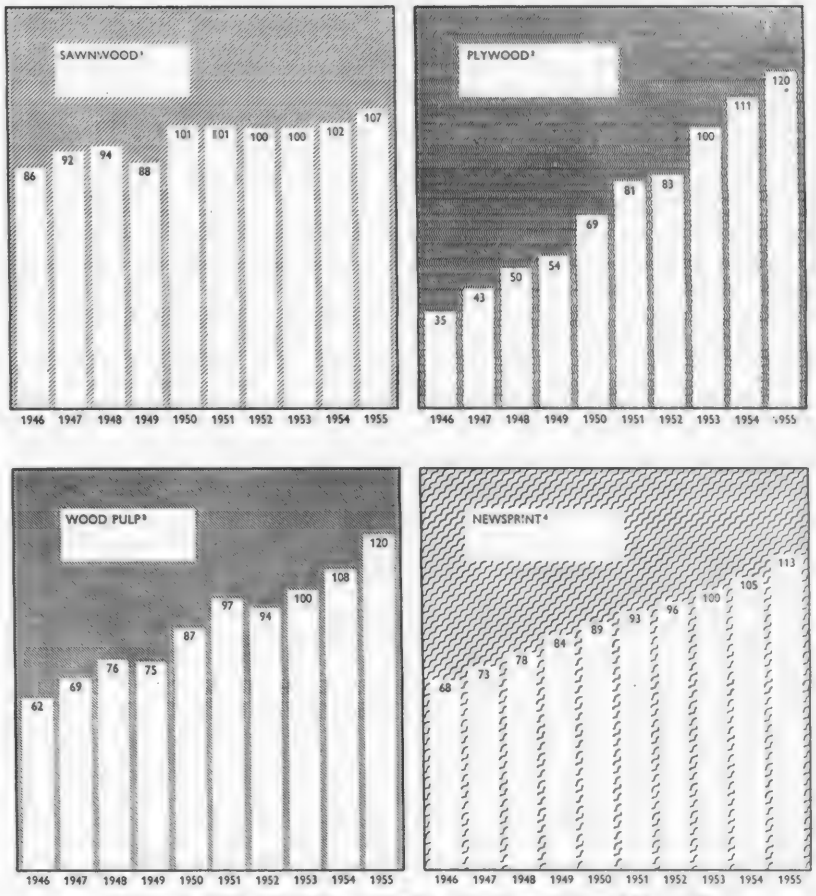
Logging Categories: Although production of fuelwood for the world as a whole has remained fairly stable for several years, it represents a steadily declining proportion of the volume of fellings, thus conforming to the general trend for more rational utilization of forest resources. The following table shows that, in Latin America, Africa, and Asia, production is still mainly in fuelwood.

	Industrial wood	Fuelwood
	Per cent of recorded fellings	
Europe	64	36
U.S.S.R.	64	36
North America	84	16
Latin America	17	83
Africa	8	92
Asia	46	54
Pacific Area	58	42
World	58	42

Wood in World Economy: The value of output of the different forest products expressed in current prices shows a continuing rise caused not only by slightly rising prices per unit, but also by an increased output of secondary forest products. This value for 1955 may roughly be estimated at U. S. $29,800 millions against $27,800 millions in the previous year, broken down as follows:

	Millions of U. S. dollars	
	1954	1955
Products of sawlogs*	13,100	14,000
Products of pulpwood†	7,100	8,000
Pitprops	400	400
Other industrial wood	1,100	1,100
Fuelwood	2,400	2,500
Minor forest products	3,700	3,800
Total	27,800	29,800

* Sawnwood, veneers and plywood.
† Paper, board and fibreboard.



Trends in world production (selected countries). Index: 1953 = 100.

World Trade

The rise in trade noted for 1954 continued at an accelerated pace for all forest products during the year under review. Exports, expressed in roundwood equivalent, totalled for reporting countries 153 million cu. m., thus surpassing last year's record level by 18 million. Exports increased for the main commodities as follows:

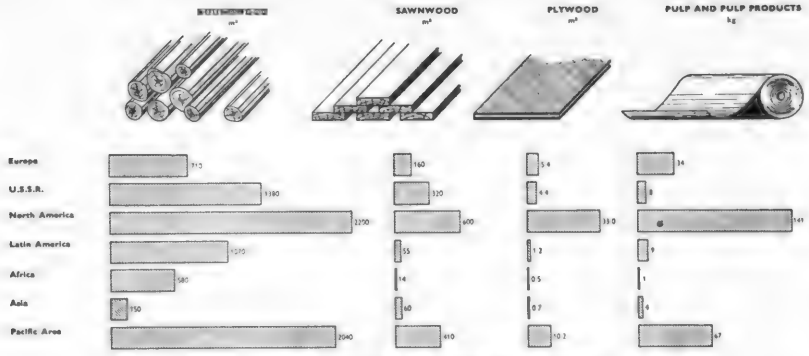
	Per cent
Pulpwood	28
Sawlogs	15
Sawnwood	12
Wood pulp	11
Plywood and veneers	22
Fibreboard	27
Newsprint	7

The greater volume of trade, together with a slight increase in prices, caused a substantial rise in the value of the forest products entering international trade from the reporting countries. The value of exports totalled U. S. $4,966 millions in 1955 against $4,288 millions in 1954, thus showing an increase of 16 per cent. The value of imports of reporting countries rose to U. S. $5,386 million, against $4,441 millions in the previous year. The following table shows that Europe and North America accounted for more than four-fifths of total reported values:

	Percentage of international trade	
	Imports	Exports
Europe	50	49
North America	29	40
Latin America	6	4
Africa	4	3
Asia	8	4
Pacific Area	3	--

Lumber

Production: World output of sawnwood increased nearly 4 per cent, amounting to 294 million cu. m. against 277 million in the previous



Consumption per capita (reporting countries only).

year. The highest rate of increase was in U.S.S.R. with 10 per cent, whereas North America led with the highest volume increase, 5½ million cu. m. The chart showing production of lumber in selected countries (representing 58 per cent of world's output) indicates that in the year under review, output was 24 per cent higher than just after World War II.

World production of coniferous sawnwood, accounting for 80 per cent of the total output of sawngoods, rose to 50½ million standards, about 7 per cent over the 1954 mark. Hardwood output increased in all regions except North and Latin America from 57.2 million cu. m. in 1954 to 57.4 million in 1955.

Trade: A further rise in international trade of sawn soft- and hardwood (including boxboards) took place in 1955, reaching 35.2 million cu. m. (export) or 12 per cent more than in the previous year, a rate of increase equal to last year's. Almost all the greater exporting countries extended their shipments, with the exception of Austria, Poland, Rumania and Yugoslavia. The U.S.S.R. increased its exports (excluding eastern Europe) by 683,000 cu. m. or 47 per cent over the previous year. The following table shows the regional balances of reporting countries for sawnwood (including boxboards):

	Net balance*			
	Sawnwood			
	Coniferous		Broadleaved	
	1954	1955	1954	1955
	1,000 cu. m. (s)			
Europe	—1,495	—2,430	—500	—680
U.S.S.R.	+1,146	+1,887	—129	— 64
North America	+4,130	+3,935	—214	—237
Latin America	+ 120	+ 360	+ 14	+ 97
Africa	—1,355	—1,310	...	+ 50
Asia	—	— 840	+720	+800
Pacific Area	— 560	— 700	— 40	—110

*Net exports +; net imports —.

Consumption: Apparent consumption of all sawnwood in reporting countries increased by about 7 per cent from 1954. An increase of about 7 per cent was recorded for the coniferous species and for the broadleaved about 6 per cent. Consumption per head of population differs from region to region, depending not only on the availability of the products, but also on purchasing power, living standards, industrial production, and agricultural output. The highest consumption level is noticed in North America with over half a cubic meter per head, and the lowest in the under-developed regions of Latin America, Asia, and Africa. Within the regions the level of consumption by no means is uniform, ranging from a minute fraction of a cubic meter to two-thirds of a cubic meter per head.

Plywood

The uninterrupted expansion of this industry continued in 1955 and output now passed the 10 million cu. m. mark. World production (including blockboards) is estimated at 10.4 million cu. m. against 8.9 millions in 1954, thus showing a rise of 17 per cent. Nearly all countries showed increases in production, with particularly notable expansion recorded in France, Canada, United States and Japan.

Trade in plywood also expanded during 1955, reaching in reporting countries an export volume of 990,000 cu. m. against 820,000 the previous year. The countries which led the increase in exports were Japan (rise of 69,200 cu. m.), U.S.S.R. (26,300), Canada (23,100) and Finland (22,400). The United Kingdom and the United States, the two biggest importers and accounting together for over 73 per cent of the reported world totals, increased their intakes by 97,000 cu. m. and 114,100 cu. m. respectively.

Wood Pulp

Production: Pulp output reached in 1955 an over-all high of 48 million tons, and exceeded the 1954 production by about 9 per cent. Increases were noted in all regions, but percentagewise the largest increases in output were in Africa, Asia and Latin America. World production of chemical wood pulp showed an increase of 3.2 million tons or nearly 12 per cent, whereas in mechanical wood pulp it was about 3 per cent and in other vegetable fibre pulp about 9 per cent. The following table shows the percentage distribution for the production of the three types of pulp in 1955:

	Wood pulp		Other fibre pulp
	Mechanical	Chemical	
	%	%	%
Europe	32	57	11
U.S.S.R.	37	63	0
North America	30	68	2
Latin America	35	59	6
Africa	0	60	40
Asia	30	51	19
Pacific Area	50	47	3
World Average	31	63	6

Paper and Paperboard

Production of all categories of paper and board increased considerably during the year under review and surpassed last year's record level. Total output in 1955 was 56.1 million tons or nearly 10 per cent over that of the previous year. About one-fifth of the pulp products were newsprint and one-third board. North America continues to be the leading producer, with 58 per cent of the world's output, whereas Europe produced 29 per cent, Asia 6 per cent, U.S.S.R. 4 per cent, Latin America 2 per cent, and the Pacific area 1 per cent.

Paperboard: Board output increased in 1955 by 12 per cent from 16.8 million tons in 1954 to 18.9 millions. Except for the Pacific area where production showed a decline of nearly 7 per cent, production rose in every region especially in North America where the increase of 14 per cent represented a volume of over 1½ million tons.

Fibreboard

World production of insulating board and hardboard continued its upward trend and reached a new record level of 3.2 million tons against 2.9 millions in 1954, a rise of 11 per cent. Hardboard production from 1954 to 1955 increased by 11 per cent, insulating board by 10 per cent. North America and Europe account together for some nine-tenths of the world's output. The leading producers, the United States, Sweden and Canada increased their out-turn by about 11 per cent.

World trade in fibreboard represents about 16 per cent of total production. Sweden, which accounts for half of all exports, increased its shipments by 47,000 tons or 22 per cent. The leading importer, the United Kingdom, increased its intakes by nearly 44,000 tons or 35 per cent, thus enlarging its share of the world's reported imports to 39 per cent.

Abstracts From Current World Literature

Veneer and Plywood

Improved positioning during the breakdown of logs for veneer slicing by a new turning device. *Holz–Zbl.* 81 (116), 1955 (1387).

Describes a superstructure to a log carriage, manufactured by E. Schulte, Hamm (W. Germany), in two sizes (for logs of 1.25 and 1.60 m. maximum diam.), in which the ends of the log are gripped between two chucks on a frame adjustable for lengths from 1.50 to 5.0 m. These chucks can be rotated mechanically through 45° or 90° at a time, the motor cutting out automatically when the exact angle is reached. Motors for operating the gripping device and for raising the log for a median cut also have automatic cut-outs. Increased speed and safety of operations are claimed, particularly with heavy exotic timbers. [For. Abs. V. 17, No. 1]

Glues and Gluing

A. Charlesby. Atomic radiation treatment of polymers. *Research,* Vol. 8, August 1955, pp. 288–94.

Long-chain polymers consist of molecules containing as many as 100,000 atoms arranged in a linear or branched chain. Polyvinyl acetate (PVA) is one of these substances. If the long-chain molecules which these polymers contain can be cross-linked to form molecules of an even higher molecular weight, the substance will change from the liquid to the solid state. It has been found that this cross-linking may be performed by atomic radiation: it may be possible to cure PVA glues by this means. The article stresses that the subject is still in its infancy and that, at present, the cost of equipment is extremely high. [F. D. C. Tech. Bul. V. 5, No. 29]

Seasoning

Shrinkage tests. *Rep. For. Prod. Res. Bd., Lond. 1954,* 1955 (10).

Shrinkage tests on Elm gave similar results to those previously carried out on beech [see *For. Abstr.* 15(No. 656)], indicating that samples slowly dried at high temperatures tended to shrink appreciably more than matched samples slowly dried at low temperatures. Shrinkage started at high moisture contents, well above the generally accepted value of the fibre saturation point. Tangentially cut speciments expanded initially at high temperatures. Slow drying produced considerably more shrinkage than fast drying, and the shrinkage of specimens dried very rapidly appeared to be independent of temperature. [For. Abs. V. 17, No. 1]

Moisture Movement

Babbitt, J. D. The movement of moisture through solids. *ASTM Bull.* no. 212: 58–61 (Feb., 1956).

The author reviews the various physical concepts which relate to the movement of moisture through solids and analyzes moisture movement in its six possible states—vapor, liquid, solid, chemical compound, adsorbed, and dissolved. [Bul. Pap. Chem. V. 26, No. 8]

Wood Properties

Wardrop, A. B. and Dadswell, H. E. The nature of reaction wood. IV. Variations in cell wall organization of tension wood fibres. *Australian J. Botany* 3, no. 2: 177–89 + 7 plates (1955); *cf.* B.I.P.C. 24: 97–8.

The cell-wall organization, cell-wall texture, and the degree of lignification of tension-wood fibers have been investigated in a wide variety of temperate and tropical species. Following earlier work describing the cell-wall structure of tension-wood fibers, two additional types of cell-wall organization have been observed. In one of these, the inner thick "gelatinous" layer which is typical of tension-wood fibers exists in addition to the normal three-layered structure of the secondary wall; in the other only the outer layer of the secondary wall and the thick gelatinous layer are present. In all the tension wood examined the micellar orientation in the inner gelatinous layer has been shown to be nearly axial and the cellulose of this layer found to be in a highly crystalline state. A general argument is presented as to the meaning of differences in the degree of crystallinity of cellulose. The high degree of crystallinity of cellulose in tension wood as compared with normal wood is attributed to a greater degree of lateral order in the crystalline regions of tension wood, whereas the paracrystalline phase is similar in both cases. The degree of lignification in tension-wood fibers has been shown to be extremely variable. However, where the degree of tension-wood development is marked as revealed by the thickness of the gelatinous layer the lack of lignification is also most marked. Severity of tension-wood formation and lack of lignification have also been correlated with the incidence of irreversible collapse in tension wood. Such collapse can occur even when no whole fibers are present, e.g., in thin cross sections. Microscopic examination of collapsed samples of tension wood has led to the conclusion that the appearance of collapse in specimens containing tension wood can often be attributed in part to excessive shrinkage associated with the development of fissures between cells, although true collapse also occurs. Possible explanations of the irreversible shrinkage and collapse of tension-wood fibers are advanced. [Bul. Pap. Chem. V. 26, No. 6]

Machining

Harris, P. Cutting action of tools. *Research* 9, no. 3; 109–13 (March, 1956).

The behavior of wood under a cutting tool is discussed in comparison with that of metal. The technique used in studying the influence of grain direction, cutting angle, feed speed, and depth of cut on chip formation is described. Information is given on the cutting action of saws and cutters as observed by stroboscopic, high-speed photographic, and other means. Methods of overcoming difficulties that arise in working timbers of abrasive nature or with special grain characteristics are also outlined. [Bul. Pap. Chem. V. 26, No. 8]

Wood Preservation

Trussell, P. C., Anastasiou, C. J. and Fulton, C. O. Protection of saw-logs against marine borers [I] Treatment of flat rafts by ponding. *Pulp Paper Mag. Can.* 57, no. 2: 67–71 (Feb., 1956).

A method for the killing of the marine borer, *Bankia setacea,* in sawlogs arranged in flat-raft formation is described. The method is based on ponding the raft in a shallow tidal basin to which is added sodium arsenite concentrate. Holding the raft in the sodium arsenite solution for 6 to 7 hours between high tides has been found adequate for a complete kill of all borers in the logs. [Bul. Pap. Chem. V. 26, No. 8]

Trussell, P. C., Fulton, C. O., Anastasiou, C. J. and Gillespie, R. E. Protection of saw-logs against marine borers [II] Treatment of deep-sea rafts. *Pulp Paper Mag. Can.* 57, no. 2: 71–6 (Feb., 1956).

A method is described for killing *Bankia setacea* in sawlogs in deep-sea rafts. By spraying a dilute solution of sodium arsenite on the raft, all marine borers in treated raft sections were killed. The chemical cost of treating a full-size deep-sea raft of the Davis type is $400–500. Marine borer losses amounting to $8,000–10,000 may be prevented by such a treatment. Tests indicate that the sodium arsenite treatments can be made without affecting fish survival. [Bul. Pap. Chem. V. 26, No. 8]

The preparation of abstracts from world literature in many languages is so highly specialized and costly that the Forest Products Research Society has no abstracting service of its own. For the abstracts in this issue of the JOURNAL the Society is indebted to the respective abstract journals indicated, from which they have been selected with the kind permission of the editors. Readers wishing information in addition to that given in these abstracts should consult the original articles referred to. Copies or additional information can not be supplied by FPRS or the abstract journal. The journals from which abstracts are published in this issue are as follows:

BULLETIN OF THE INSTITUTE OF PAPER CHEMISTRY, published monthly at Appleton, Wisconsin by the Institute of Paper Chemistry, subscription price $25 per year. This Bulletin publishes over 3,600 abstracts per year on subjects of interest to manufacturers of pulp, paper, fiberboard and allied products.

CHEMICAL ABSTRACTS, published semimonthly by the American Chemical Society, Executive Office—1155 Sixteenth Street, NW, Washington 6, D. C., subscription price $60 per year plus postage. This abstract journal publishes many thousands of abstracts annually with broad coverage of world literature in the entire field of chemistry and allied subjects.

FORESTRY ABSTRACTS, published quarterly by Commonwealth Agricultural Bureaux, Farnham Royal, Slough, England, subscription price $8.40 per year. The abstracts are prepared by the Commonwealth Forestry Bureau, Oxford, England, and include a Forest Products and Utilization section. This section contains over 1,500 titles and abstracts per year from literature in some 30 languages, covers all aspects of forest utilization.

TECHNICAL BULLETIN OF THE FURNITURE DEVELOPMENT COUNCIL is published bimonthly by the Council at 11 Adelphi Terrace, London W. C. 2, England. The Technical Bulletin publishes hundreds of abstracts and reviews from world literature annually, relating to the various phases of the furniture manufacturing industry. Subscription price is $5 per year.

Foundation and Methods of the Anatomical Investigation of Wood[1]

and

Caucasian Woods[2]

A. A. YATSENKO-KHMELEVSKY

ALTHOUGH BOTH of these books appear under a single authorship, the preface in the first and the title page in the second indicate that parts of each represent a cooperative effort of several workers.

The first text *(Osnovi i Methodi Anatomicheskovo Issledovanya Drevesini)* is divided into two parts, each containing several chapters. Part I is entitled Terminology, and Part II, Special Methodology for Anatomical Investigation of Wood. An extensive bibliography of Russian literature, followed by a comprehensive bibliography in the foreign languages, is appended. A final highly useful feature of this book is a comparative glossary of wood anatomical terms in Russian, English, German, and French.

Part I starts with definitions of terms employed in describing the anatomical features of wood. In many instances these are accompanied by further explanatory notes and by drawings. It is notable that only a few of the illustrations are photographs, and these are generally of somewhat inferior quality. It is here that the quadrilingual glossary is of particular assistance. By and large the definitions used correspond closely with those adopted by the International Association of Wood Anatomists. However, repeated references are also made to an earlier glossary by the author.

A brief chapter follows on the Technique of Preparing the Material. It is surprising to find that the author is an advocate of the razor blade technique. He sees no advantages for the microtome, except when relatively large cross sections are wanted.

The next chapter, more than 50 pages long, deals with detailed plans for describing the anatomical features of each species. Whether or not one agrees with the emphasis given to this subject, as keynoted by the opening sentence in this chapter, "A basic requirement of any investigative work in the sphere of wood technology must be a clear general understanding by the worker of the anatomical structure of wood studied by him", the proposed plan is well conceived and thorough.

Chapter IV deals with the techniques of measuring wood elements and reliability of such measurements. The effect of internal and external factors responsible for cell size variations are also discussed.

The second part of the book is introduced by a comprehensive discussion of regional sources of information, both Russian and foreign, dealing with descriptions and identifications of the woody plants. Here considerable emphasis is also placed on the identification of the paleontologic material. The following chapters deal with the place of wood anatomy in systematic botany and with physiological changes occuring in wood after its formation, e.g., formation of tyloses and heartwood and the possible role living parenchyma may play in fungal attack.

A review of the effect of environmental growth factors on the rate of growth, as indicated by the width of the growth rings, and general characteristics of wood, and a brief discussion of the effects of wood structure on its physical and chemical characteristics and its utilization, conclude the text.

The stated purpose of the book is to bring together all information that can be of interest to specialists concerned with wood structure. It is further stated that the book is aimed at people in technical phases of wood processing, as well as at those interested in botanical aspects of wood technology. In the opinion of the reviewer the former may find the book slanted too much toward the latter. Nevertheless this publication is a real contribution to the technical literature in the field of wood technology. For American workers its chief value may be in the wealth of text references to the publications largely unknown to us, by Russian scientists.

The other volume—*Drevesini Kavkaza*—contains detailed information on the wood of the Caucasian species. The anatomical descriptions follow the plan suggested in the third chapter of the first book. The descriptions in most instances are accompanied by drawings of the cross and tangential sections, at about a hand lens magnification. Some of these drawings are rather inadequate for conveying the desired information. Data on physico-mechanical properties of the more important woods are included, as is the pertinent information on their utilization in the Soviet Union. Frequently, information on the related exotic species is also incorporated.

The volume is a valuable contribution to the regional literature on identification and properties of wood producing species, even though most of those described are not of commercial value either locally or elsewhere.

It is unfortunate that the author should, in the preface to this soundly scientific publication, engage in Marxist dialectics.

A. J. PANSHIN
Michigan State University

[1] Osnovi i Methodi Anatomicheskovo Issledovanya Drevesini. Academy of Science of U. S. S. R., Moscow, U. S. S. R. 1954. 337 pp. Illus. 22r. 10k.

[2] Drevesini Kavkaza. Academy of Science, Armenian S. S. R. Erevan. 1954. 674 pp. Illus. 24r. 20k.

NEW PRODUCTS—LITERATURE

New Wallboard and Corner Tape

Two related products for use in dry wall construction have been developed by the Upson Co., Lockport, N. Y. The new products are waterproofed, super-smooth surface boards for interiors and a phantom tape system for finishing inside corners. Samples of both products are available from the manufacturer.

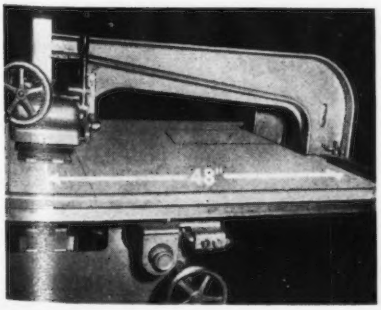
Laminated from six plies of wood fiber to a thickness of approximately 3/8 inch, the wallboard is made with a vapor barrier on the back for use

on the inside face of exterior walls, and a standard back for application to partitions. Called Super-Bilt, the panels are 8 feet wide and available in lengths up to 20 feet.

The phantom inside corner tape reportedly can be worked smoothly and securely into corners to blend with the surface of Super-Bilt panels. Dry wall joint cement is used for the first filling application and dry wall topping for the second coat. The second coat is feathered out slightly beyond the edge of the first filling and sanded lightly to blend with the wallboard.

Wide-Arm Rip Saw

A "wide-arm" rip saw, with 48 inches usable throat clearance is announced by G. M. Diehl Machine Works, Inc., Wabash, Ind. The new rip saw is said to incorporate all features of the Diehl No. 750 plus adding 92 per cent more usable saw space to the right of the blade.



Hardboard and plywood manufacturers will find the saw particularly applicable for sizing, equalizing, trimming, and cutting to dimension, the manufacturer reports. It will reportedly speed production for furniture manfacturers in cutting chipcore and hardboard to size, equalizing large plywood panels and corestock, and sizing of cores simultaneously with reject ripping. It is claimed to be suitable for any other special applications requiring more than standard 25-inch throat capacity.

Bulletin on Resins for Boards

A bulletin which summarizes methods employed and Perkins adhesives suitable for the manufacture of particle board is available from Perkins Glue Co., Lansdale, Pa., or Kitchener, Ontario. The pamphlet, Technical Service Bulletin No. 56, describes equipment, methods of production, and types of board that can be produced.

The bulletin estimates the quantity of wood waste needed to start a profitable operation for manufacture of particle board at 8 to 10 tons of waste per day for 260 days per year. Equipment is estimated to cost from $100,000 to $375,000. The batch and extrusion methods of manufacturing particle board are described.

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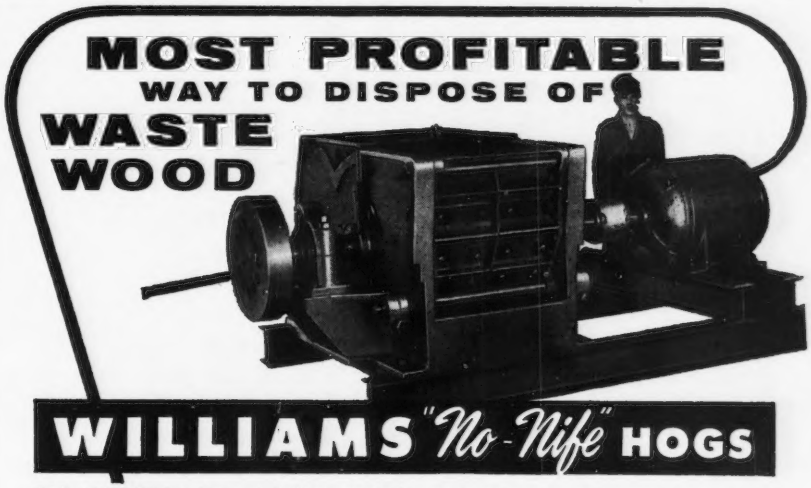

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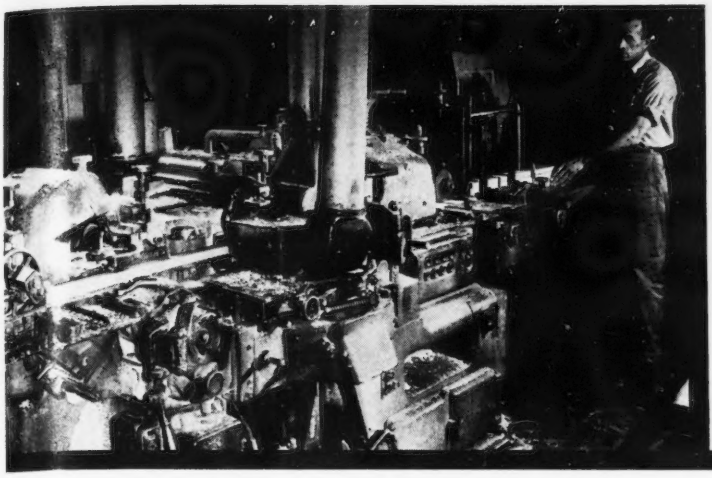

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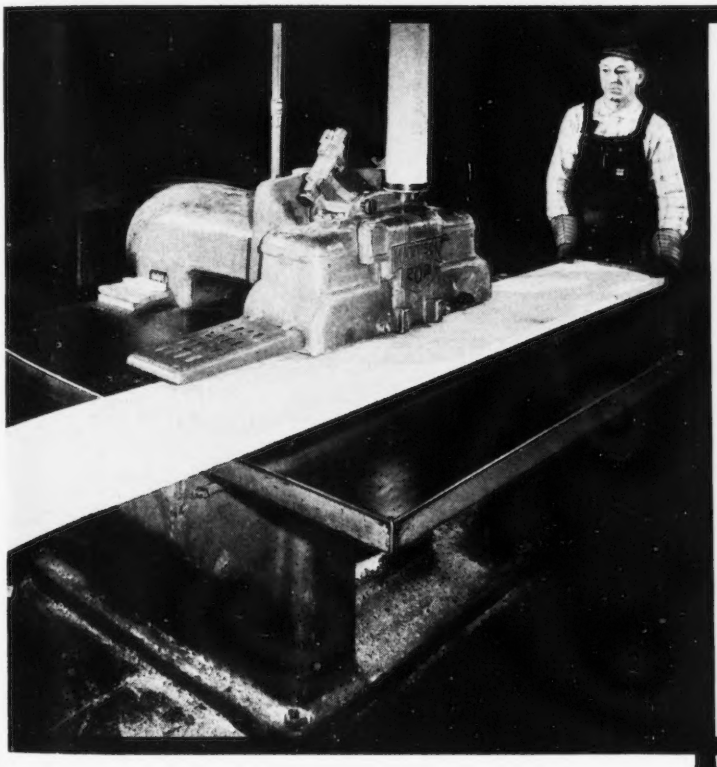

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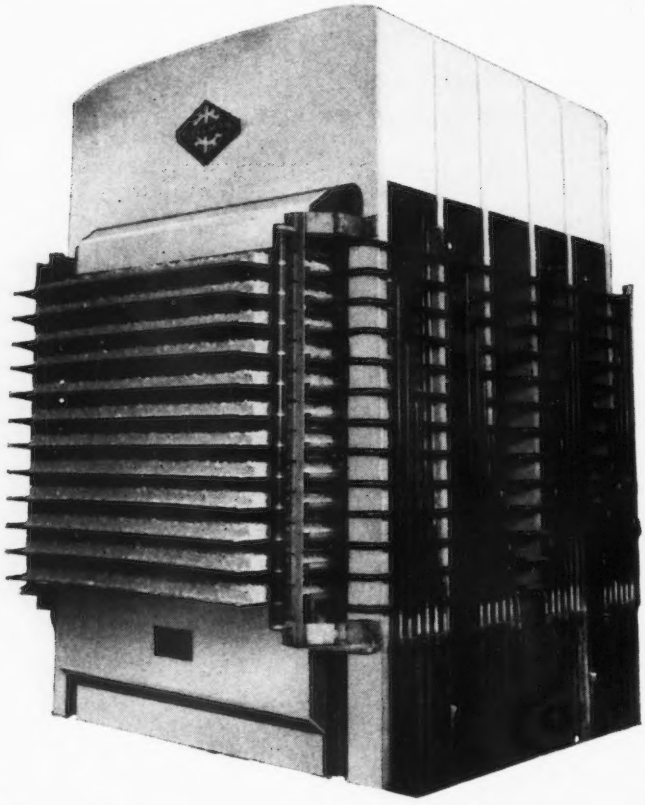

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